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MONOGRAPHS ON EDUCATION

IN THE

UNITED STATES

EDITED BY

NICHOLAS MURRAY BUTLER

President of Columbia University in the City of New York

9

SCHOOL ARCHITECTURE

AND

HYGIENE

BY

GILBERT B. MORRISON,

Principal of the Manual Training High School, Kansas City, Missouri

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DEPARTMENT OF EDUCATION

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MONOGRAPHS

ON

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SCHOOL ARCHITECTURE AND HYGIENE

The school house is an infallible index of the educational status of the community in which it is located. It stands at once a monument and a history of the mistakes or successes, the ignorance or wisdom, the poverty or opulence, the parsimony or generosity of the people who have erected and maintained it. From the forbidding shanty on the country cross roads in the backwoods to the palatial edifice in the most enlightened city, this building tells a story in letters so plain and so unmistakable that " he who runs may read." The school house teaches not alone a lesson in architecture, but lessons in sanitation, in engineering, in æsthetics, and in pedagogics. The building from the school-room furnishings and devices for teaching to the finishing touches of the exterior, is a composite resultant of the work of teacher, superintendent, school director, engineer, and architect.

The growth of the American school house is commensurate with the growth of American education. From the four bare walls where the three R's were formerly taught to the modern laboratory or art room in which are combined the appliances for the best teaching and for the expression of the best taste, these material evidences epitomize the educational situation in our country. The consideration of school house building, therefore, becomes a question of the highest importance.

The necessary features to be secured in building a school house named in the order of their relative importance are, 1. Shelter; 2. Adequate space; 3. Warmth; 4. Ventilation; 5. Light; 6. Interior furnishings and appliances; 7. Beauty.

The ends to be attained in all of these features are essentially the same for all types of buildings from the one-room

country school house to the most expensive structure built in the city for high school or college purposes. The application of the principles involved in securing these ends in buildings of every variety of cost and function requires a vast diversity of treatment.

In all of the above-named features of a building, the three ends to be sought are hygienic, economic, and mechanical. In all cases alike, it is mechanical skill and ingenuity working with the means at their command to reach the best hygienic results. The features requiring the greatest skill are warming and ventilating, and the general architectural effect given to the building in its construction and in its location.

In his book on "The Warming and Ventilation of School Buildings," the writer has treated somewhat in detail the principles underlying the subjects of the present essay, and it is his object here to outline in the briefest manner to what extent these principles have been put into practice in the school houses of the United States. In order to do this, he has thought best to select some of our best buildings as examples representative of the various types, pointing out their merits and calling attention to their defects, and suggesting where improvements could be made. To fully treat in a thorough and scientific manner the principles involved in building a school house is beyond the scope of this article. The object here is simply to embody into the discussion of a few types the results of the best theory as exemplified in the best practice.

THE COUNTRY SCHOOL HOUSE

The majority of the children of the United States go to school in the country. The country school house, therefore, deserves its share of attention. On account of economic conditions, the instruction must be carried on in a single room of sufficient size to accommodate the children. In many of the states the unsanitary conditions usually prevailing in rural districts have been partially overcome by proper oversight on the part of intelligent supervisors.

As economy is the chief end to be considered in most rural districts, a plan by Wm. P. Appleyard and E. A. Bowd (Plate I) is selected as meeting a sufficient number of the necessary requirements to form an intelligent basis of treatment.

While this house can be built for about $600, it presents a neat and attractive appearance. Its exterior reveals the touch of the architect's hand, and the educational influence of such a building when located on a well-selected site can hardly be overestimated.

The building is 24x32 ft., outside measurement, and comprises a school room, a fuel room, a wardrobe for boys, a wardrobe for girls and a porch; it will furnish shelter for thirty pupils in single seats, or thirty-six pupils in double seats. The single seat should always be provided where the rigor of economy does not positively forbid it. The single seat is an American characteristic, and its moral influence on the pupils in the freedom it gives them from too close proximity, as well as its assistance to the teacher in maintaining order, commends it to universal use.

There remains very little to be said about the proper seat to be provided in furnishing a school room. The seats now on the market and furnished by all dealers in school furniture are, in the main, models of convenience, comfort and finish. It certainly stands to the credit of this country for having invented and brought into almost universal use the best seat which any country has produced. These seats are graded in size to suit the age of the pupils. A room improperly seated in the United States is at the present time only chargeable to the grossest ignorance, indifference or neglect.

The heating is accomplished by means of a stove placed in one corner of the school room. The time-honored practice of placing the stove in the center of the room has given way to a better knowledge of the principles of heating and ventilating. The function of the stove, when the demands of economy require its use, is the heating of the room by convection, not by radiation. While the radiated heat from the sun or from an open fire is most cordial and beneficial,

the reverse is true of radiated heat from a stove. The air in a room can be heated almost as quickly by a stove placed in one corner as in the center and by enclosing it in a jacket of sheet metal the parching radiation is intercepted. In the present case, the stove serves the purpose both of warming and of ventilation.

The diminished specific weight of air when its temperature is raised and its tendency therefore to rise lessened furnishes the basis for all methods of so-called natural or gravital ventilation.

In this building, the chimney is divided into two parts, one for smoke and the other for a foul air vent. A fresh air duct leading from the outside of the building to an opening directly under the stove supplies the fresh air. As the air in the room becomes heated, it has a tendency by its specific lightness to rise through the foul air vent in the chimney, its place being constantly supplied by the cold fresh air as it flows through the fresh air duct becoming heated as it passes up between the stove and the zinc jacket enclosing it.

The foul air duct would become still more efficient if the chimney instead of being partitioned had simply contained the stove pipe extended to the top. A heavy galvanized iron pipe should be erected and securely fastened by stays anchored to the brickwork when the chimney is built.

The chimney for a single room should have an interior cross sectional area of at least five square feet, and the pipe should be placed in the center of it. By this means the whole chimney not occupied by the pipe becomes a vent or aspirating chimney in which an upward current is maintained by the heat from the pipe. The foul air reaches this vent through a duct leading from a box beneath the teacher's platform. The part of the floor under the platform is lowered to form the under side of the box while the top of the platform forms the upper side. The air finds access to this foul air box through openings or registers placed in the riser of the platform.

The total area of these registers, and also the cross sec-

tional area of the fresh air duct should be about equal to that of the chimney. A throttle damper should be placed in the fresh air duct so that the air may be regulated in severe cold weather or retained in the room during the night to prevent its becoming too cold. The exit registers should also be closed at night.

In order that the air may not be overheated as it passes the stove, and thus rendered unfit for breathing, the stove should be large, so that the increased area of heating surface may obviate the necessity of extreme overheating. Besides, the danger from overheating the air by highly heated surfaces, it should be remembered that iron when raised to a red heat becomes pervious to the poisonous gases of combustion. One of the products of coal combustion is carbon monoxide (CO), a very poisonous gas, which, if allowed to escape, will contaminate the air.

The method of conveying the foul air into the aspirating chimney shown in Mr. Appleyard's plan has been modified in various ways in different localities. In a plan drawn by Edbrook & Burnham, architects, Chicago, used in some of the school houses in Wisconsin and Illinois; and in a similar plan drawn by Hackney & Smith, architects, Kansas City, Mo., and used in some of the school houses in Missouri, the exit registers are multiplied and placed in the floor near the base board at intervals around the room. The foul air gathering "box" thus becomes the entire space between the floor and the ground below, the opening into the chimney being below the floor, as in the former case. A sanitary objection to this arises in the fact that in warm weather, when the inside is cooler than the outside air, the draft is liable to be reversed and the "ground air" under the house drawn up into the school room.

In another modification, shown in plans drawn by John R. Church, Rochester, N. Y., the numerous exit registers are placed in the base boards and open into ducts rising in the walls to the attic, where they converge and unite in an opening into the aspirating chimney. A mechanical objec-

tion to this arises in the interference with the free movement of the air imposed by the large amount of friction in numerous small ducts.

There is really nothing gained by multiplying details in conveying air from a room. The simplest is always the best way. An ordinary wing register placed in the vent flue just above the floor is probably a better means of conveying the foul air than any of the processes just mentioned. It is simple, economical, direct and frictionless.

It should be remembered that the position of exit registers near the floor is here recommended, not because this is the ideal position for them, but because it is necessary in a room heated by a stove to trap the air in the upper part of the room, and to keep it from escaping before it has been utilized. This position of exit registers is also necessary with all systems of heating which have heretofore been in use in school-house building, but unnecessary in a stage of pneumatic engineering which we are approaching, reference to which is made on a subsequent page.

A still better means for removing the foul air is the open fireplace. This is used in a few districts in some of the northern states. It is to be regretted that the virtues of the open fireplace in school buildings have not been more widely recognized. Whether considered from a hygienic, economic or mechanical standpoint, this old-fashioned but neglected device is much to be commended. When it was discovered that the open fire does not furnish an adequate means of warming in severely cold weather, it gradually gave way to more effective modern devices; its value as a means of ventilation, however, was not sufficiently appreciated to save its almost total abandonment. When combined with a stove so as to receive into it the smokepipe, the open fireplace chimney is not expensive. In moderate weather when little heat is required, the open fire would meet the demands of warming and fulfill all the requirements of perfect ventilation.

The strong, upward draft through an open fireplace chimney when the outside is cooler than the inside air, even

without fire in the grate, is a matter of common observation. Every country school house should have an open fireplace. A small fire kept burning would ventilate the room, supplement the heat of the stove, and produce by its cheerful, radiating effect a wholesome influence on the pupils.

As the radiation from an open fire does not warm the air except secondarily from the solid surfaces of objects intercepting the rays, the open fire cannot be employed for warming except in mild weather; but its other advantages here mentioned make it a most profitable investment.

The lighting of the house shown in Plate I, while ample in its aggregate, has the defect common to most schoolhouses — that of light on two sides. A school room designed for academic purposes should be lighted on one side only. The length of the room should exceed its width by a ratio of about 3 to 2. While this ratio may vary within reasonable limits, the width should not be greater than twice the clear height. The windows on one of the longer sides should extend to the top of the room, should be well shaded, and as numerous as architectural requirements will admit.

The hygienic necessity of protecting the eyes of the pupils by admitting the light at the left or the back has been universally recognized, but a like consideration for the rights of the teacher has been generally neglected.

In a room lighted on two adjacent sides, either the teacher or the pupils must face the light, and the teacher by common consent has been made the victim. This, more than all other causes combined, is hastening the premature weakness of the eyes of our teachers. In country school houses, the light is commonly admitted on opposite sides, but this is objectionable on account of the disagreeable and injurious effects of cross lighting. The necessity of lighting on one side only is recognized in common practice in Germany, but it has been generally ignored in the United States of America. The writer is aware that thoughtful objections have been urged in this country against limiting windows to one side of class rooms — that the practice in Germany arose

from the possibility there of admitting light from the north only, and that when admitted from the south, east or west, the direct rays will dazzle the eyes of the pupils by falling directly upon them and upon their work.

While these objections have some weight, they will not stand when the facts are carefully considered. If there is an objection to windows on a side which admits direct sunlight on certain hours of the day, it is not plain how that objection could be removed by placing windows on two such sides.

When windows are distributed on two sides of a nearly square room, as is the case in the conventional corner room in most buildings of more than one room, neither side alone is sufficient to light the room when curtains are drawn on the other side. There are two reasons for this: First, the window area is insufficient, and second, the distance across the room of the common square form or lengthwise in rectangular form is greater than the established standard for the height of windows.

The objection to rectangular rooms lighted exclusively by numerous windows on one of the longer sides may be — even though this side be on the south — entirely removed by the proper use of curtains. The curtains for such a room should be of white muslin of light weight mounted on spring rollers. A room 24x32 ft. with four large, full height windows in one of its longer sides, facing south, will, with such curtains drawn clear down, be fully lighted, when the sun is shining, with a soft, subdued, well-diffused and ample light. This has been fully demonstrated by the writer who used such a curtain for several years in a large physics demonstration room lighted on the south only by two very large windows instead of the four, five, or even six which it is easy to obtain in a building planned on hygienic principles.

The common practice of admitting light at the back of the pupils and into the face of the teacher cannot be too strongly condemned. It is wholly unnecessary, false in theory, and pernicious in practice, as the ruined eyesight of thousands of teachers can attest.

The lighting on one side only is accomplished in the country school house shown in Plate II, drawn by C. Powell Karr, architect, New York city. The estimated cost of this house is $1,200, and it may well stand as a model of buildings of this class. The school room is well proportioned, 24x33 ft., and with its seven windows on one side and a 14 ft. stud, it is amply supplied with direct and thoroughly diffused light.

The stove with its air jacket is properly located in one corner. The chimney is large and contains a properly placed smoke pipe in the center. However, had the lower part of this chimney been converted into an open fireplace, the economic and hygienic ends would be still better served. A coal room and a teacher's room add to the convenience and symmetry of the building.

A separate entrance with lobby, cloak room and hall is provided for the boys and girls — a matter of no small importance in a country school.

The back doors opening out of the halls make a proper separation between the girls' and boys' walks to the outhouses. These walks, let it be here noted, should always be covered and the sides shielded by lattice work.

One improvement is here suggested in the arrangement of the cloak and coat rooms. In order to secure light and ventilation, they should be changed from the inner to the outer wall of the halls where a window could be added to furnish the necessary light. While window ventilation is not generally recommended, its objection is less in a cloak room than elsewhere.

This house is a model of neatness and, all essential points considered, may stand as a type of the best of its class.

THE TWO-ROOM BUILDING

In small hamlets where the school population necessitates adding another room, new problems present themselves. As the hygienic requirements are the same for all rooms, these problems are chiefly mechanical.

A two-room building answering all economic and hygienic requirements could not be found, but the plan shown in Plate III, drawn by Warren R. Briggs, architect, Bridgeport, Conn., is a fair representation of the best that has been accomplished.

This building has two rooms, two hat and coat rooms, and a basement. It is estimated to cost $2,000. The basement is built of stone, and the upper part is frame. The architectural treatment gives the house a neat and attractive appearance.

As we leave the one-room building and pass to those having two or more, economy as well as convenience suggests the centralization of the heating and ventilating apparatus. The stove is enlarged, placed in the basement, and becomes a "furnace." The cold air duct conveying the air to the source of heat between the furnace and enclosing jacket is substantially the same as for the one supplying the stove in the single room, except that it has double the cross-sectional area. The jacket instead of being open at the top is closed with branch pipes leading to the rooms.

In Mr. Briggs' plan, the chimney and air ducts are situated centrally as they properly should be. The warm air is admitted near the top of the rooms through the inlet ducts and is supposed to go out at the outlets near the floor. This it will do only when there is a considerable difference between the inside and outside temperature, there being no provision made to heat these outlet ducts. By making open fireplaces of these ducts, they would be converted into effective aspirating chimneys and would also serve for warming the rooms in mild weather.

In the method of heating here shown, we see in embryo the "hot air" or "indirect" system which seems to be the best means of warming small buildings with comparatively few rooms, in which a steam or hot water plant cannot be afforded, and where the destination of the hot air is not far from the furnace. The furnace, however, in small buildings should be large that the necessity of overheating may be obviated.

The fireplace before suggested should be heated only in mild weather. In very cold weather it causes unnecessary waste of air as well as of fuel. In fact, in extremely low temperatures, ventilation generally takes care of itself unless the room is very close. This is of course due to the considerable difference in atmospheric pressure between the inside and outside walls of the room.

The rooms in the building under consideration are well proportioned — 25x35 ft.— and are well conditioned for exclusive lighting on the longer sides. This would provide a place for the teacher's platform, in the room shown on the left side of the plan, at the end opposite the entrance, throwing the light at the left of the pupils. The present position of the platform sacrifices valuable space and makes the teacher face the broadside light while seeing the faces of his pupils in shadow. The changes required by these suggestions while of the greatest importance are mechanically insignificant and simple.

Excellent as is the present plan when generally considered, it is too expensive for the ordinary hamlet district which would have to forego the luxury of a basement. To meet the economic conditions in such cases, the writer suggests a plan shown in Plate IV.

This plan gives well-lighted wardrobes with a convenient arrangement of doors.

The heat is furnished by stoves placed in the corners of the rooms. The angular position of the chimney makes it serve well the purposes of both rooms. The position of fresh air and smoke pipes are shown by the dotted lines.

The teacher's rooms, which are a convenience for many purposes, may be dispensed with where greater economy demands it.

THE THREE-ROOM BUILDING

With each addition to the number of rooms in a building, the mechanical difficulties incident to providing all the hygienic requirements increase. To supply plenty of pure, warm air to every room, to conform to the requirements of

lighting and seating, to provide a well-lighted and ventilated coat and cloak room adjacent to each school room, to have ample and well-lighted corriders, to plan with a view to beauty of design, and withal to keep within the bounds of economy, requires a profound knowledge of principles, practical skill and sound judgment.

As an objective basis for discussion, another building — Plate V — drawn by Mr. Briggs, has been selected. Although not ideal, this house possesses many excellent features.

An examination of the plan reveals the same defect in lighting two of the rooms that was pointed out in the two-room building,— a defect which is easy to remedy by blinding the windows on one end and moving the teacher's platform. The only other defect noticeable in this plan is the use of the main hall for coat and cloak rooms. In the present case, however, this defect is not without compensating advantages. It gives freedom, room, and publicity in the putting away and the taking down of wraps, and it economizes space.

The objection which usually prevails against the hall as a place for wraps is the odor which is liable to come from the drying of wet outer garments. This objection, however, is partly answered in the present building by the position of the heating and ventilating chimneys, which secures good ventilation for the hall, and thus prevents any currents of air from the hall into the school rooms.

The chief merit of this building is its centrally located, compact and ample heating and ventilating apparatus. The position, size, and quality of this breathing apparatus is as important in a building as are corresponding features in the lungs of an animal. The central location is economical and gives a proper balance to the distribution of air. The hot air pipes rising inside the large aspirating chimney produce an upward current which draws the air from the rooms connected with it through the registers. The cold air passes in through the fresh air duct in the basement, is heated by the furnace, and rises between the furnace and jacket to

the pipes leading up through the large chimney to the upper part of the rooms. The exit registers placed near the floor open into the chimney.

The building has an artistic and stable appearance. Built of stone or brick, the estimated cost is $6,600. But a frame structure, providing the same conveniences, could probably be built for $5,000.

It will be unnecessary to give details of plans for a four and six-room building. Duplicating the plans for two rooms will give a good plan for a four-room building; and duplicating the plans for three rooms will give an equally good one for a building of six rooms. Staircases could easily be provided for by enlarging the halls, and this without sacrificing any of the essential features.

THE EIGHT-ROOM BUILDING

In accordance with the established grading of primary and grammar schools in this country, a building of eight rooms — one for each grade — is typical of the complete unit for this class of school work, and is the prevailing type in the small cities and towns throughout the United States. For this and other reasons now about to be mentioned, a careful consideration of this building becomes highly important.

The method for warming a building is to be determined largely by the number of rooms to be warmed and by the means at the command of the builders. The proposition to establish a steam plant for a one-room country school house, would be about as absurd as one to warm a seven-story building covering a whole block in a large city with hot air furnaces in the basement. Considering the velocity at which air moves through ducts, its rate of cooling and the friction which it encounters in reaching its destination, all methods of conveying air have their proper places and their limitations.

In the growth of the typical school house from a one to a fifty-room building, the stove, the hot air furnace, the gravital steam plant with its "direct" and "indirect" radiation,

and the forcing fan all have their appropriate places. To ask which of these means is the best is much like asking whether it is best for an animal to breathe by absorption, by spiracles, by gills or by lungs. It all depends upon the building or upon the animal. There is a time when the stove gives way to the furnace, the furnace to steam pipes alone, and steam pipes alone to steam pipes supplemented by mechanical power.

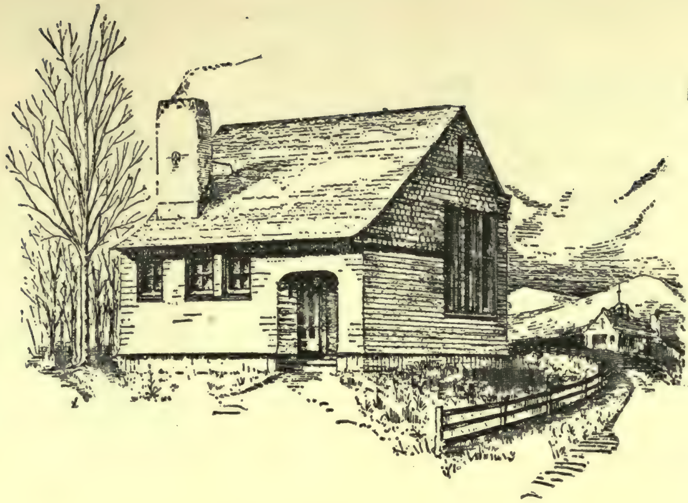
It is in buildings of the capacity of the one under consideration that the battle between the dealers in hot air furnaces and the steam fitters is usually waged, and the arguments commonly employed by both are as amusing to the scientist as they are distracting to the average school director.

It may here be said to the credit of both factions that in buildings of this size either method will answer the purpose, but the writer wishes to give as his opinion that, in constructing an eight-room building, the time has come for the installation of a steam plant.

In order to secure the proper ventilation, the radiation should be in the main "indirect;" *i. e.*, the steam pipes should take the place in the fresh air inlet duct of that formerly occupied by the furnace. Experience has proved that, in purely gravital systems, this should be supplemented with the direct radiation of a few radiators placed in the rooms under the windows. For a fuller discussion of the principles underlying these statements, see "Warming and Ventilation of School Buildings," chapters XVII and XVIII.

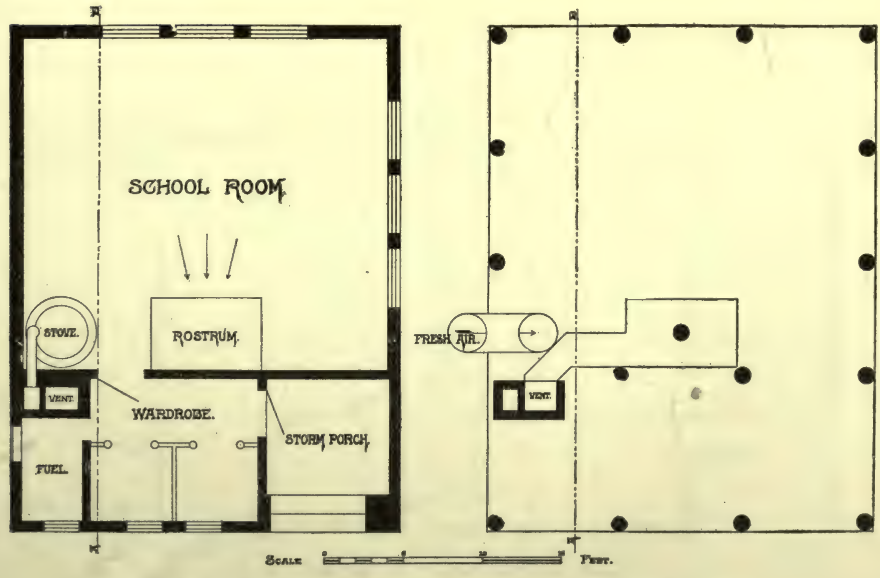
Another peculiarity which generally prevails in our eight-room buildings is that, situated as the rooms are in corners of the building, they are usually square and lighted on two adjacent sides. This error is ingeniously avoided in the fifth ward school building, Joliet, Ills., shown in Plates VI and VII.

By blinding the windows on one side and by increasing their number on the other, all the rooms are properly lighted. By an equally ingenious and artistic architectural treatment, the external appearance is made strikingly attractive. The



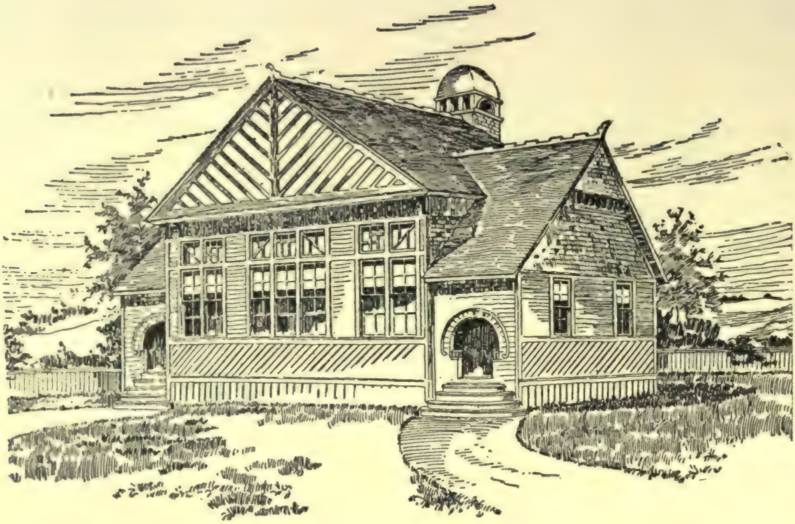
ONE ROOM COUNTRY SCHOOL HOUSE

Wm. P. Appleyard and E. A. Bowd, Architects, Lansing, Mich.



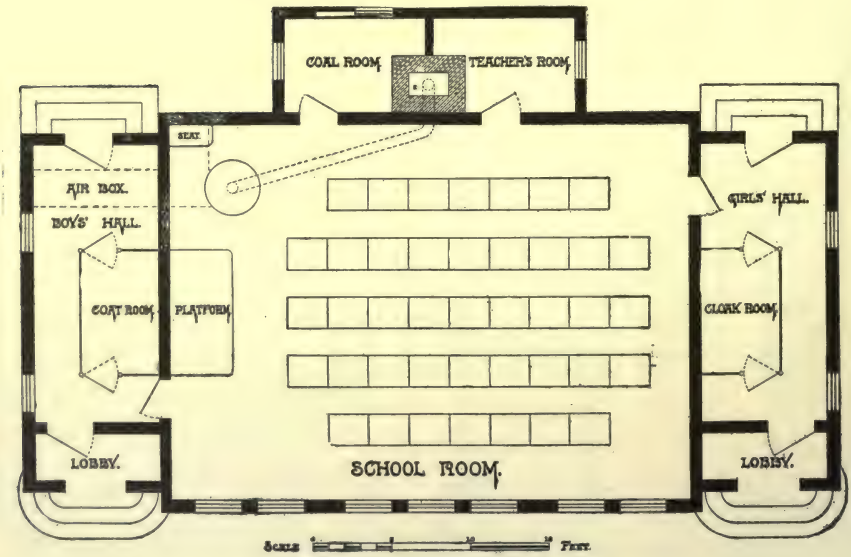
Floor Plan *Basement Plan*

PLATE II



MODEL ONE ROOM SCHOOL HOUSE

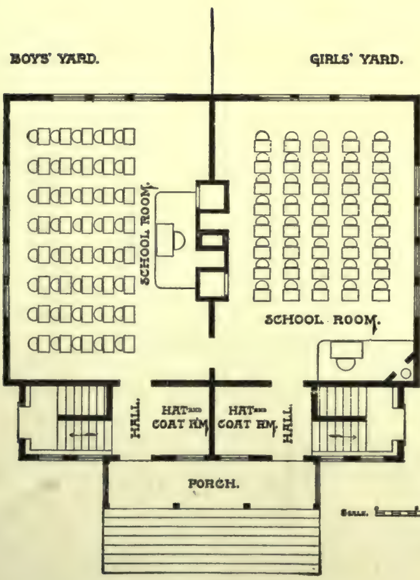
C. Powell Karr, Architect, New York



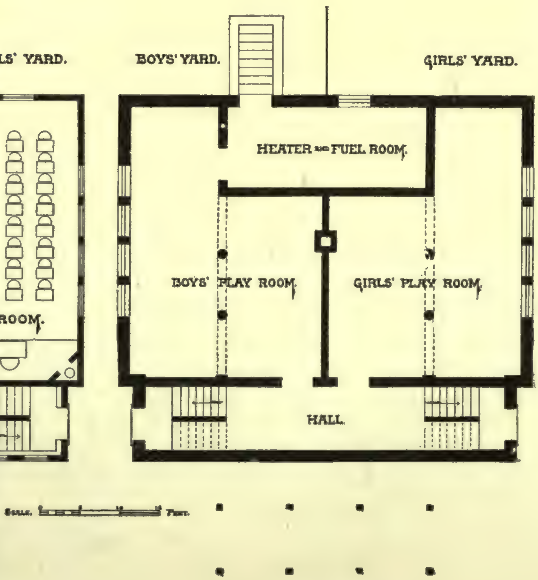
Floor Plan

A TWO ROOM SCHOOL HOUSE

Warren R. Briggs, Architect, Bridgeport, Conn.

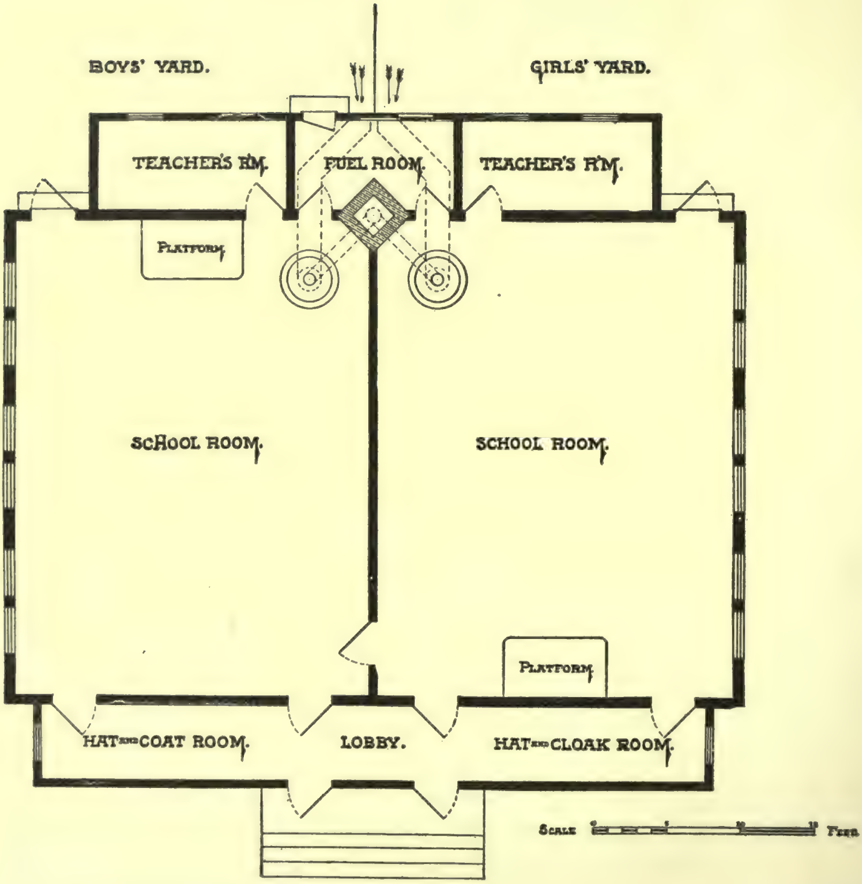


Floor Plan

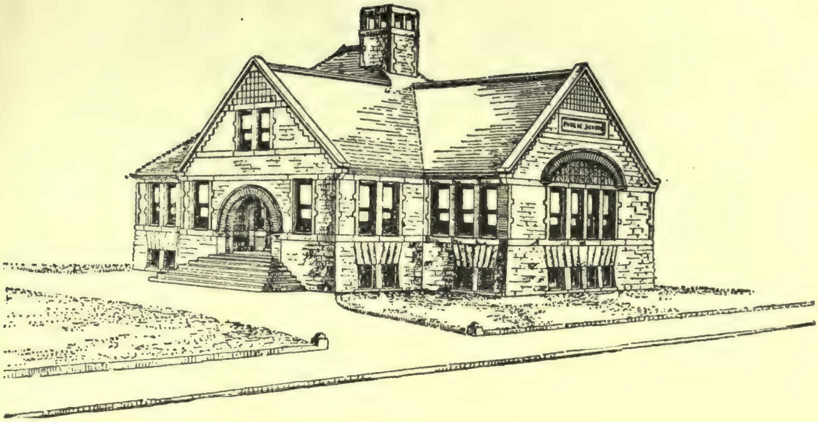


Basement Plan

PLATE IV

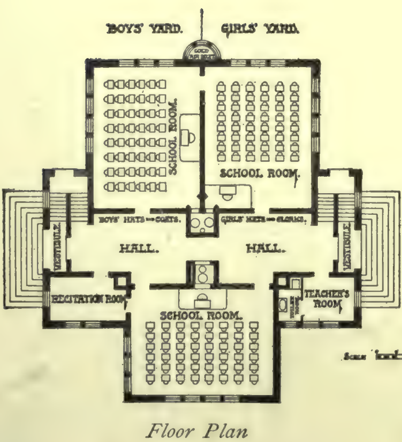


PLAN SUGGESTED FOR AN INEXPENSIVE TWO ROOM SCHOOL HOUSE

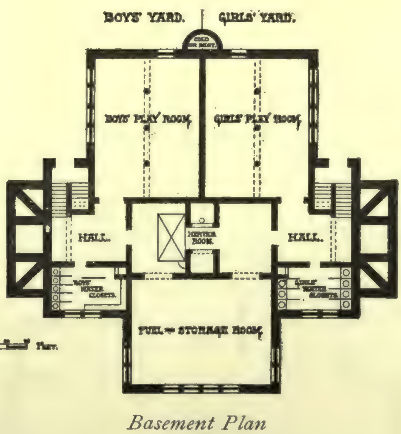


A THREE ROOM SCHOOL HOUSE

Warren R. Briggs, Architect, Bridgeport, Conn



Floor Plan

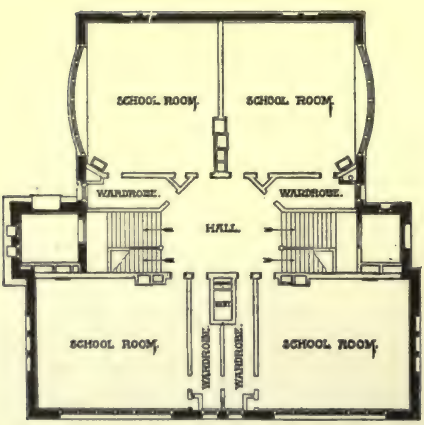


Basement Plan

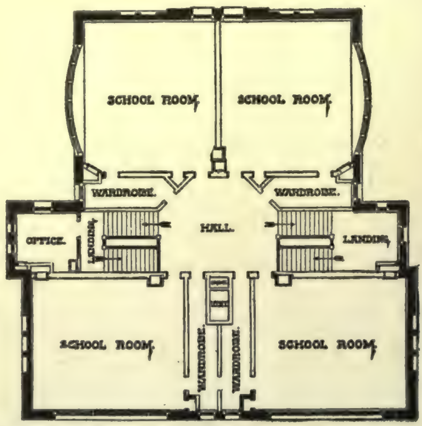
PLATE VI

FIFTH WARD SCHOOL, JOLIET, ILL.

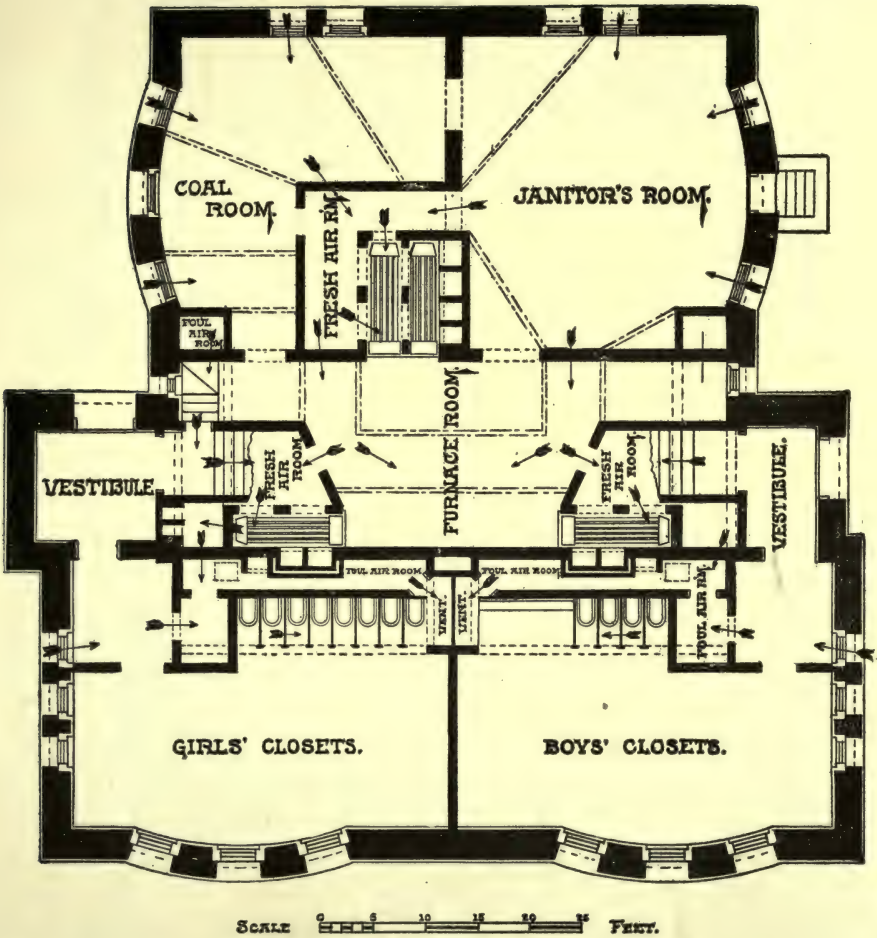
F. S. Allen, Architect, Joliet, Ills.



First Floor



Second Floor



FIFTH WARD SCHOOL, JOLIET, ILL.—Basement Plan

PLATE VIII

Fig. 1

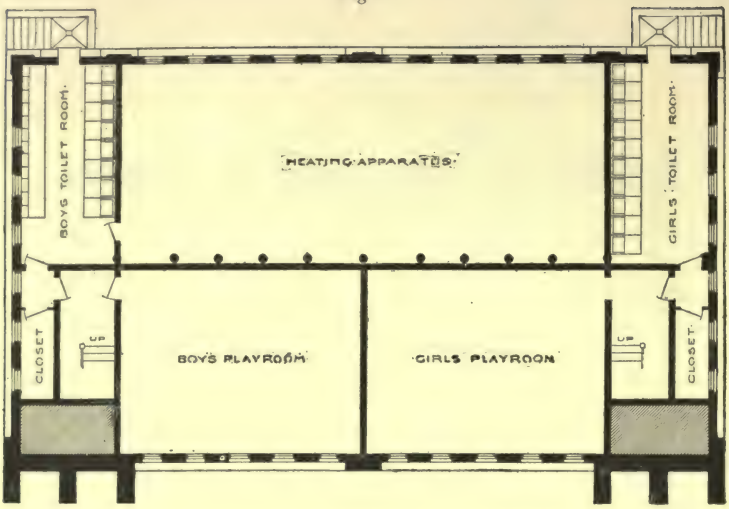
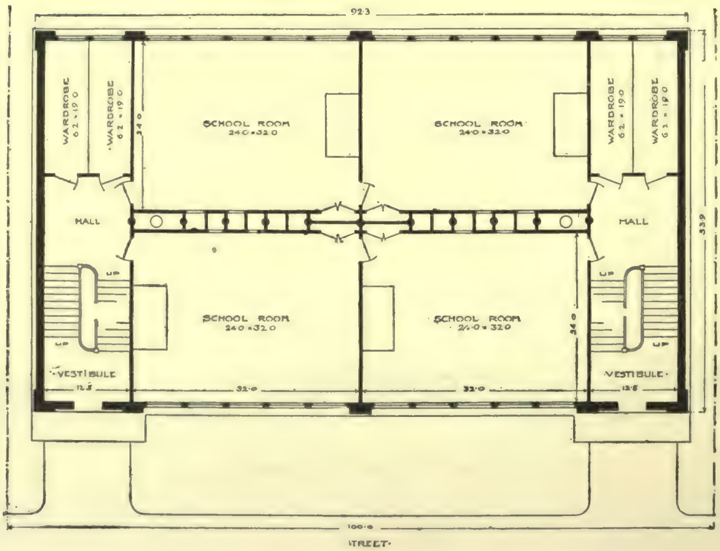


Fig. 2



BASEMENT AND FIRST FLOOR PLANS OF AN EIGHT ROOM PRIMARY AND GRAMMAR SCHOOL HOUSE

William Atkinson, Architect

Fig. 1

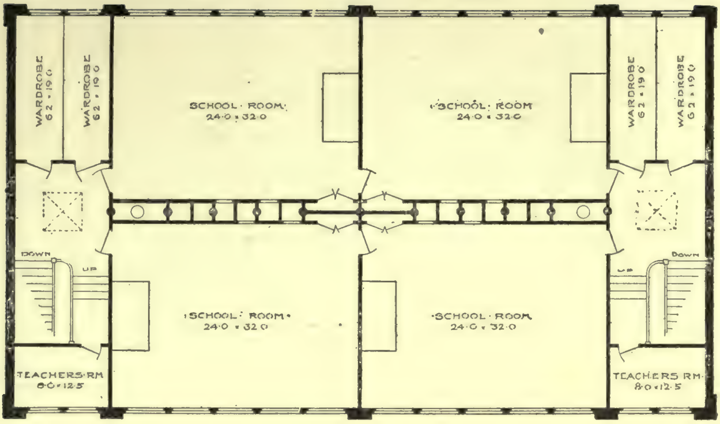
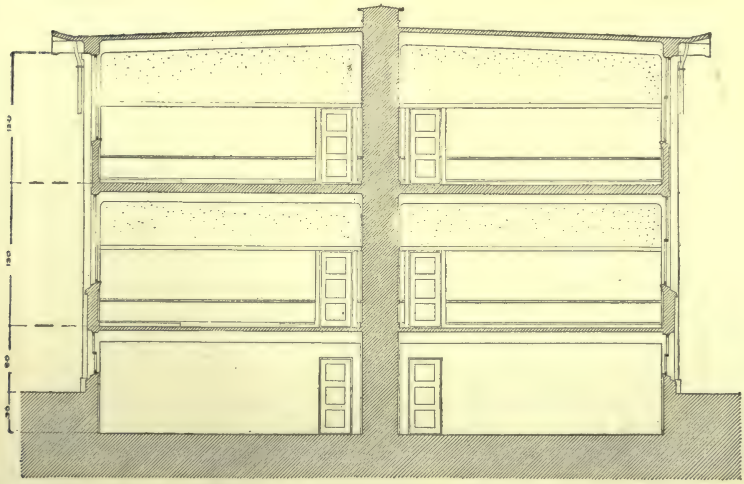


Fig. 2



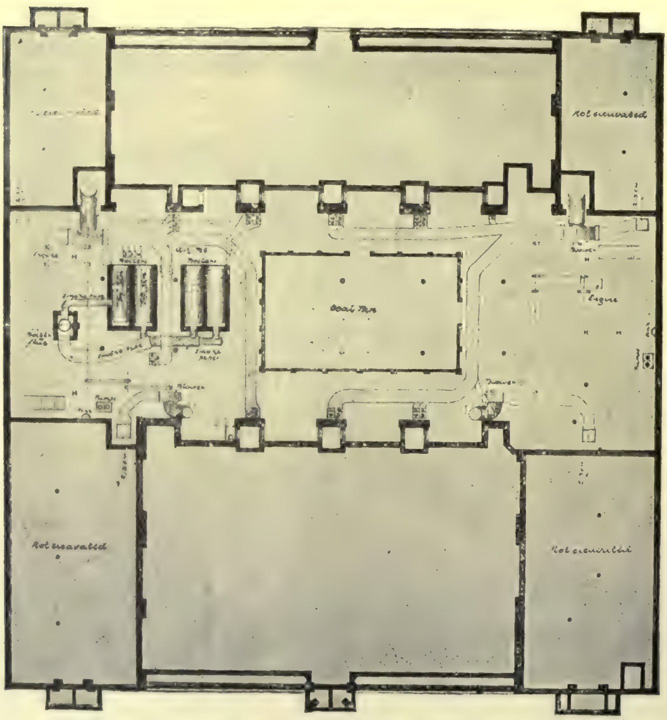
SECOND FLOOR PLAN AND SECTIONAL VIEW OF AN EIGHT ROOM PRIMARY AND GRAMMAR SCHOOL HOUSE

William Atkinson, Architect

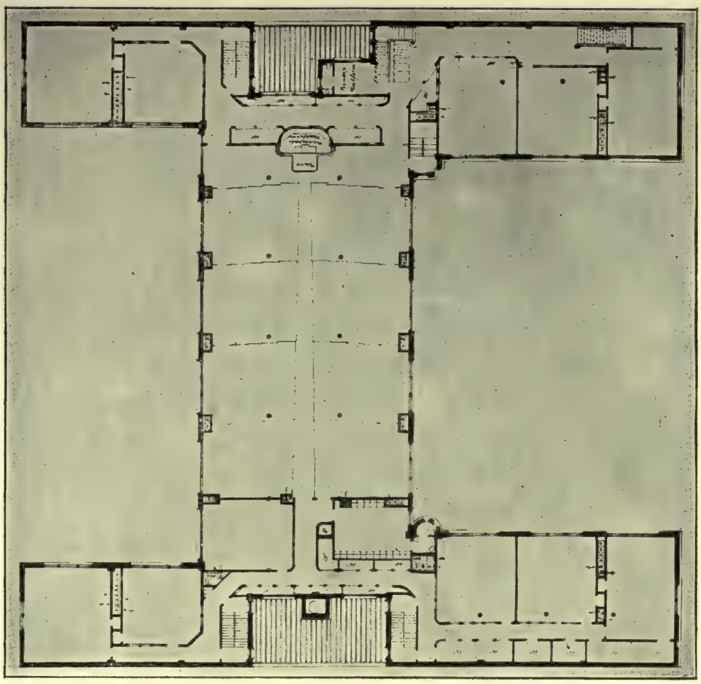
PLATE X

PUBLIC SCHOOL BUILDING NO. 165, NEW YORK CITY

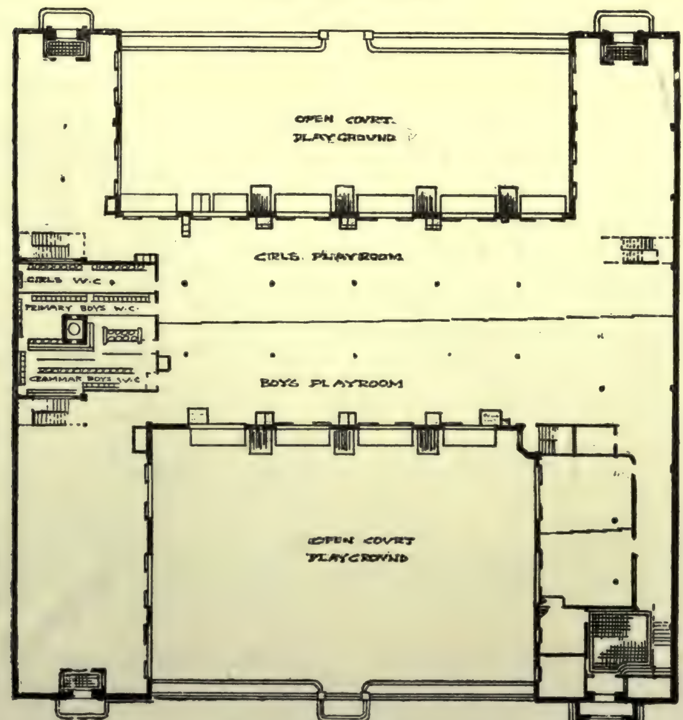
C. B. J. Snyder, Architect, New York



Basement Plan



Second Floor Plan

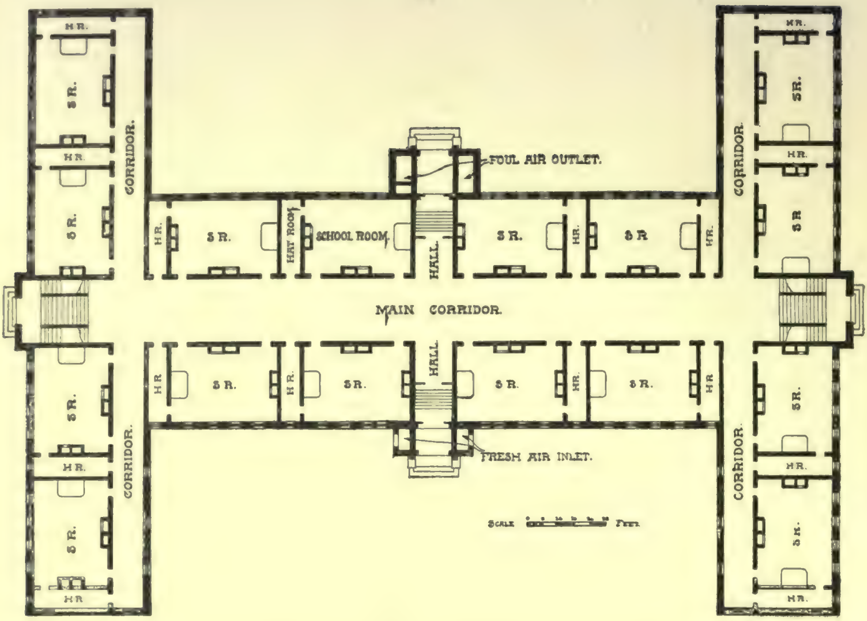


First Floor Plan

PUBLIC SCHOOL BUILDING NO. 165, NEW YORK CITY

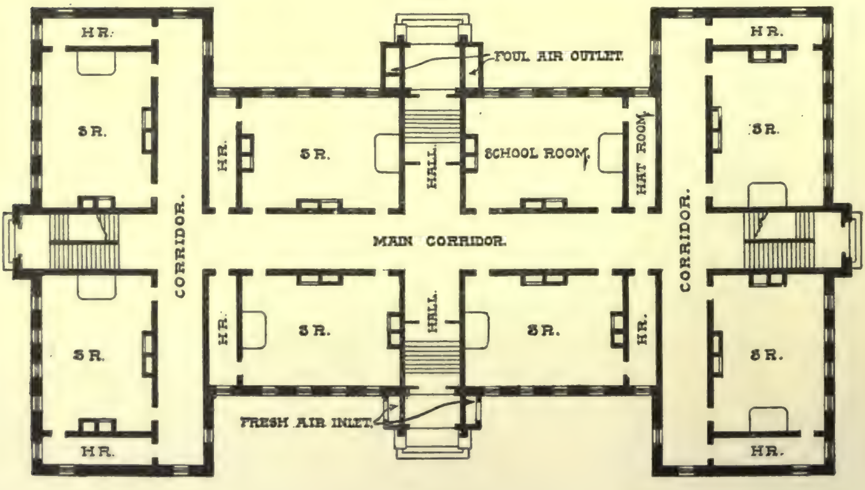
PLATE XII

Fig. 1



PLAN SUGGESTED FOR A LARGE PRIMARY AND GRAMMAR SCHOOL

Fig. 2



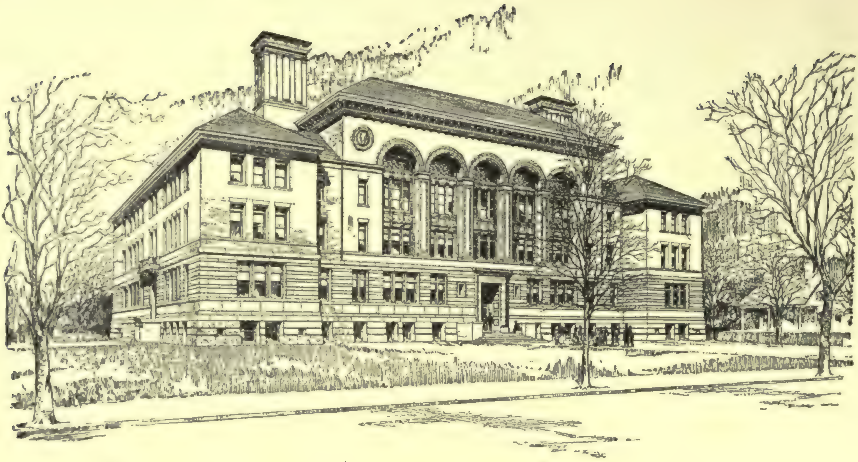
PLAN SUGGESTED FOR A SMALL PRIMARY AND GRAMMAR SCHOOL

Fig. 1

PUBLIC SCHOOL NO. 20, NEW YORK CITY
C. B. J. Snyder, Architect

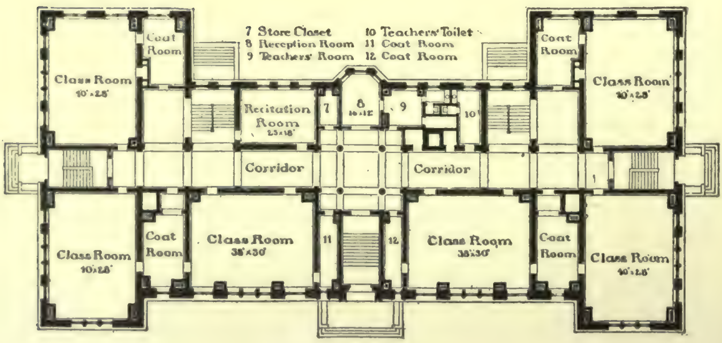
Fig. 2

Roof Playground

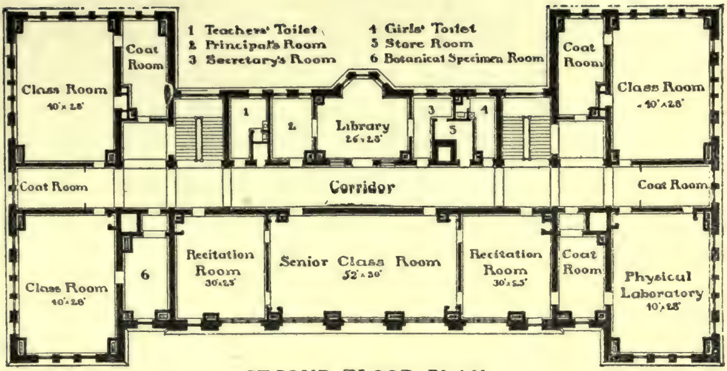


CAMBRIDGE (MASS.) ENGLISH HIGH SCHOOL

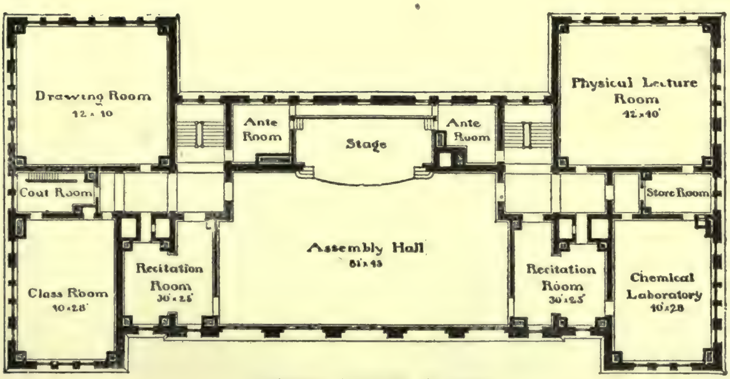
Chamberlin & Austin, Architects



FIRST FLOOR PLAN



SECOND FLOOR PLAN



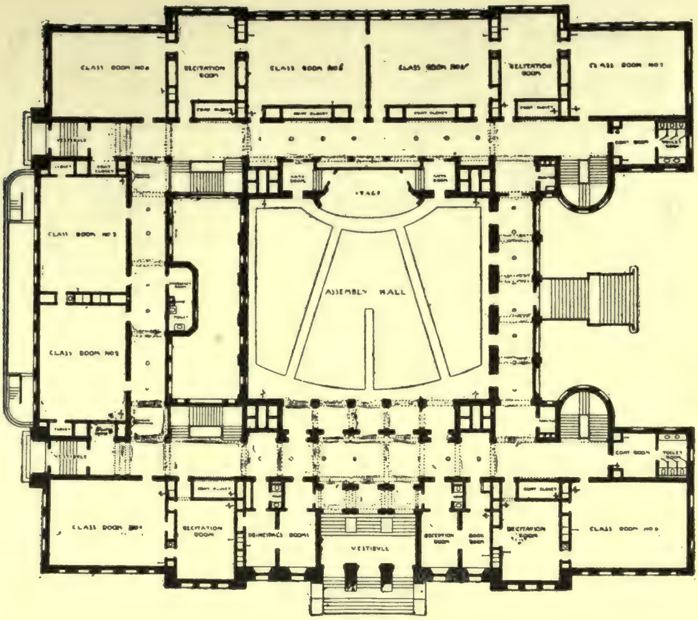
THIRD FLOOR PLAN

CAMBRIDGE (MASS.) ENGLISH HIGH SCHOOL

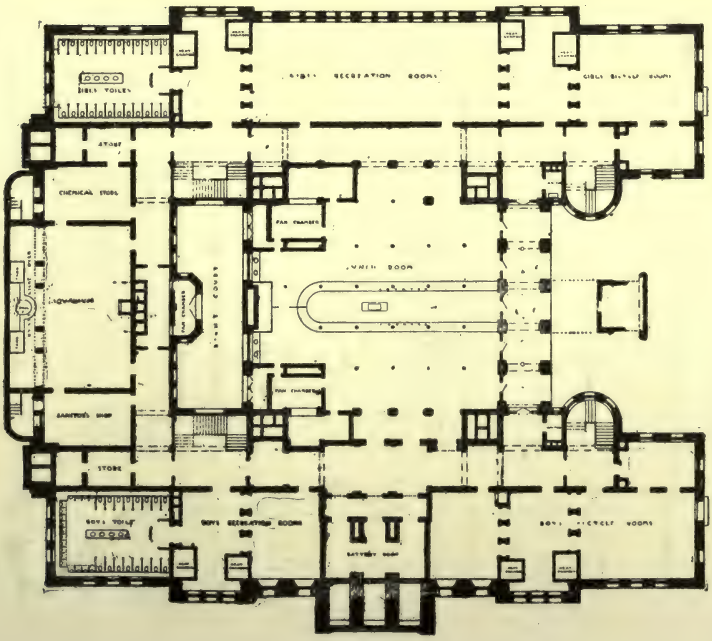
Chamberlin & Austin, Architects

SPRINGFIELD, MASS., HIGH SCHOOL

Hartwell, Richardson & Driver, Architects

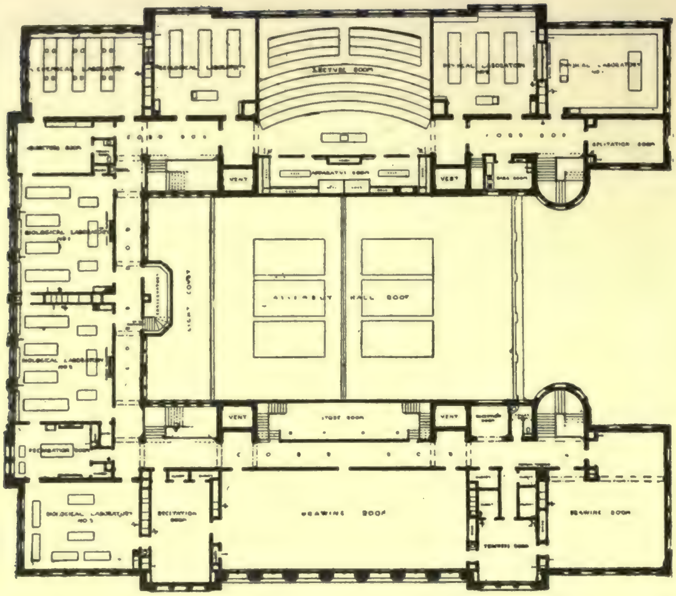


First Floor

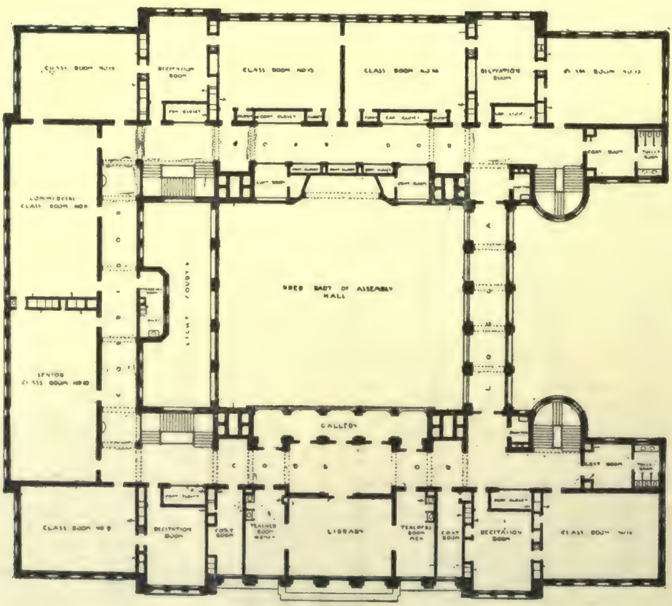


Basement

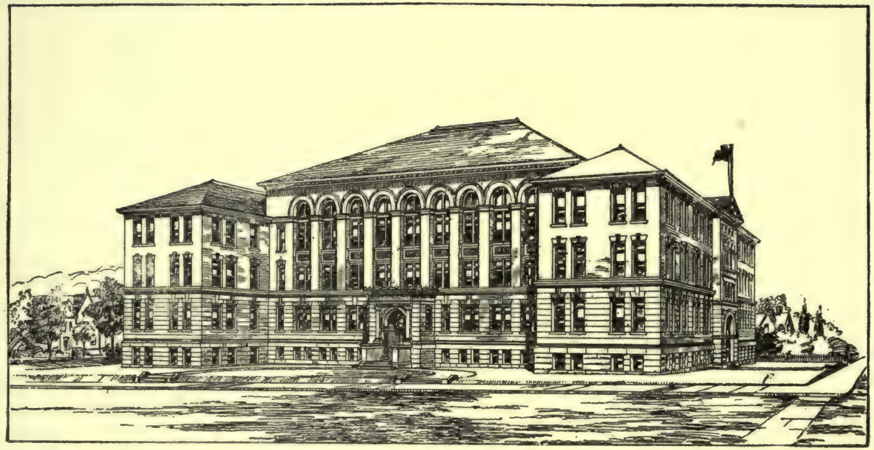
PLATE XVIII



Third Floor

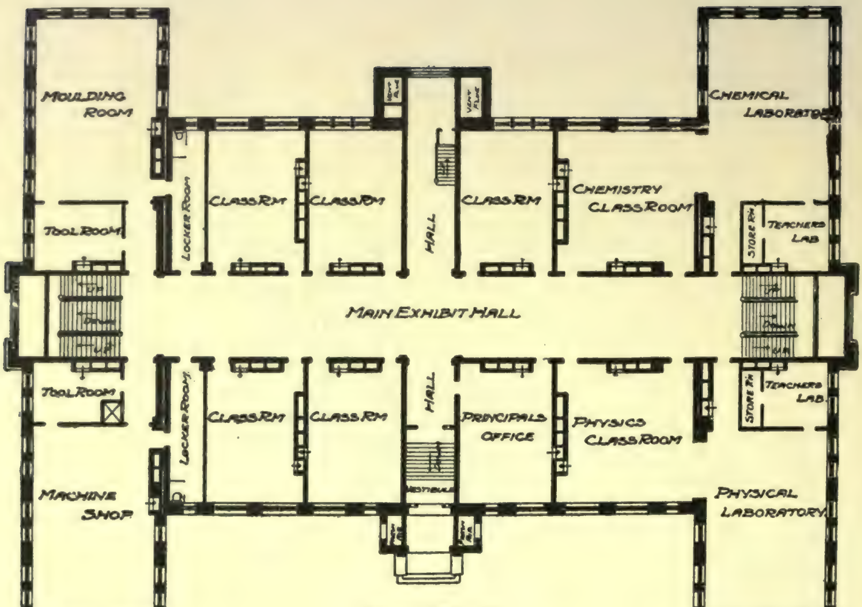


Second Floor

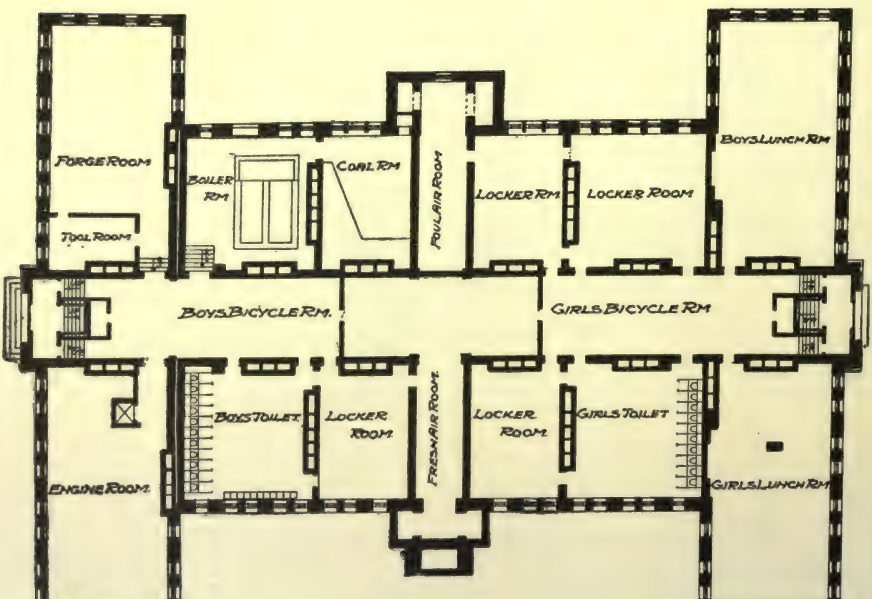


MANUAL TRAINING HIGH SCHOOL, KANSAS CITY, MO.

Hackney & Smith, Architects

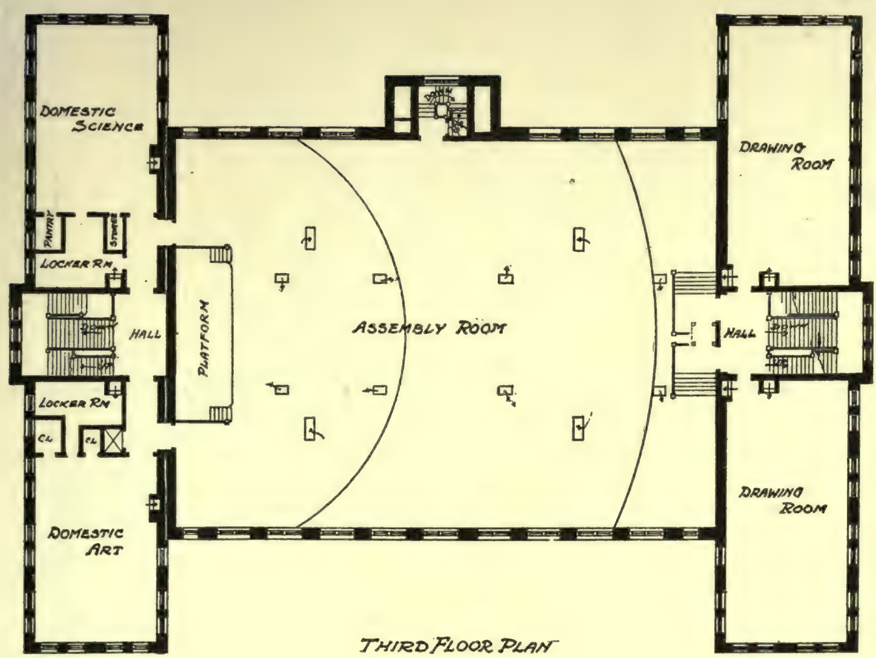


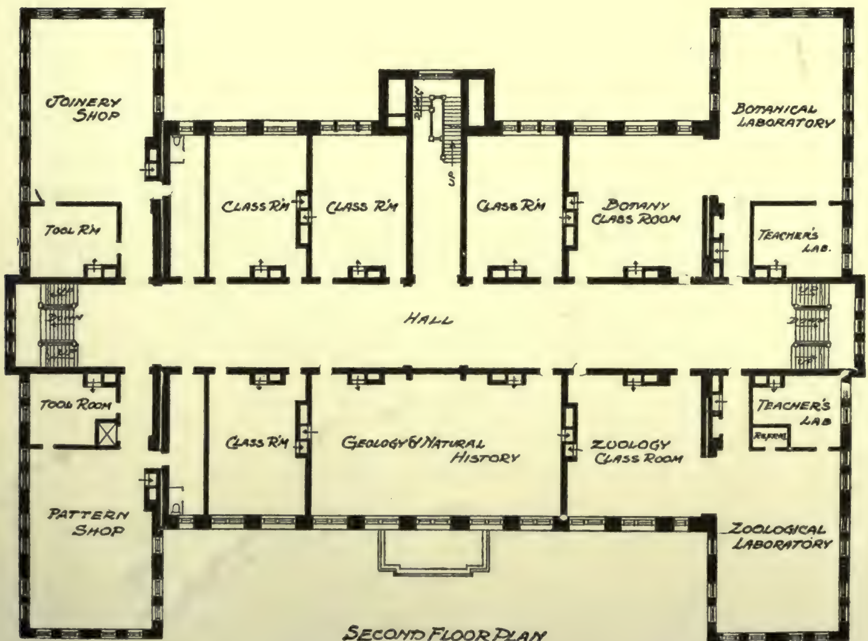
FIRST FLOOR



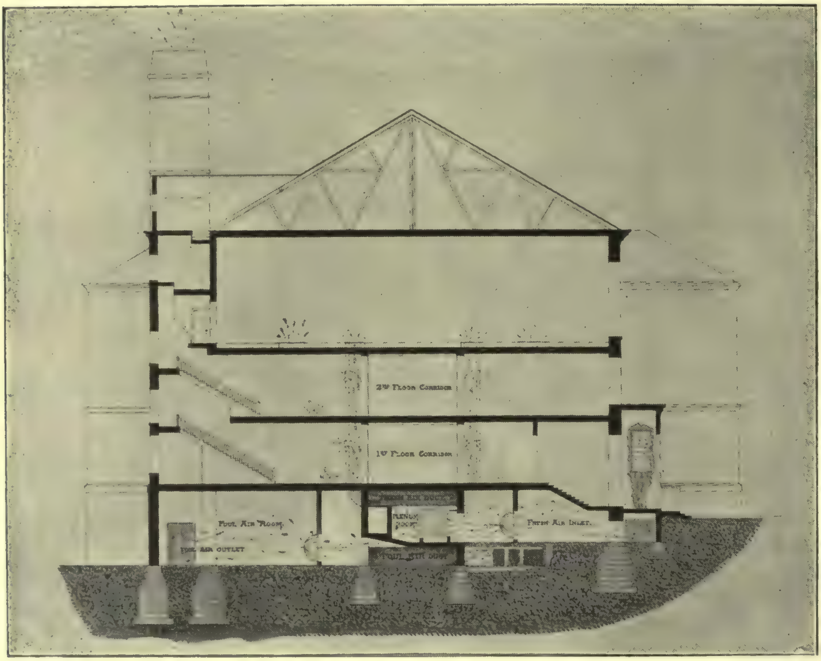
BASEMENT

MANUAL TRAINING HIGH SCHOOL, KANSAS CITY

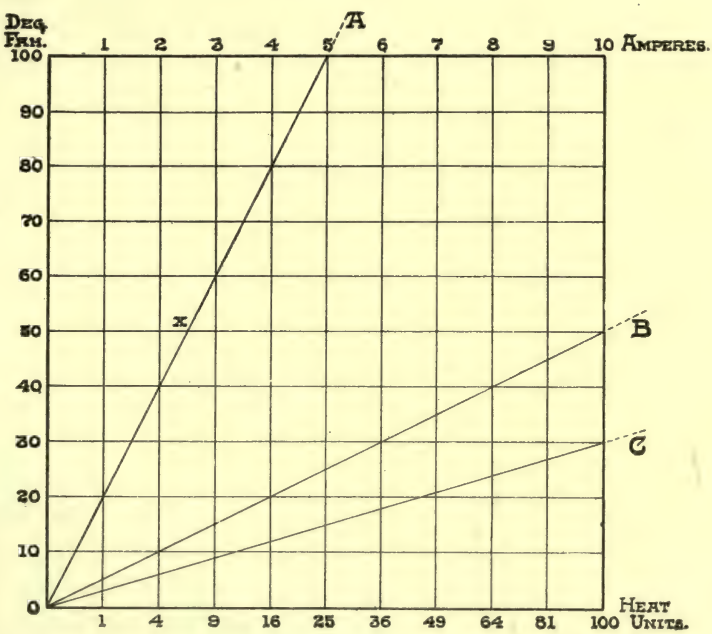




MANUAL TRAINING HIGH SCHOOL, KANSAS CITY



CROSS SECTIONAL VIEW



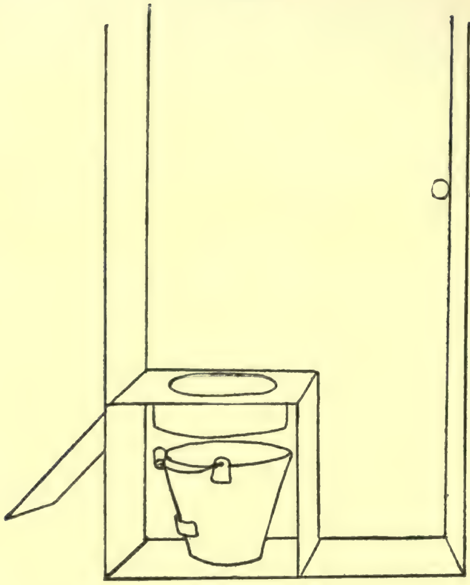
A HEAT DISTRIBUTED UNDER FLOOR, VENTILATION ABOVE.

B HEAT DELIVERED ON SIDE, VENTILATION BELOW.

C HEAT DELIVERED ON SIDE, VENTILATION ABOVE.

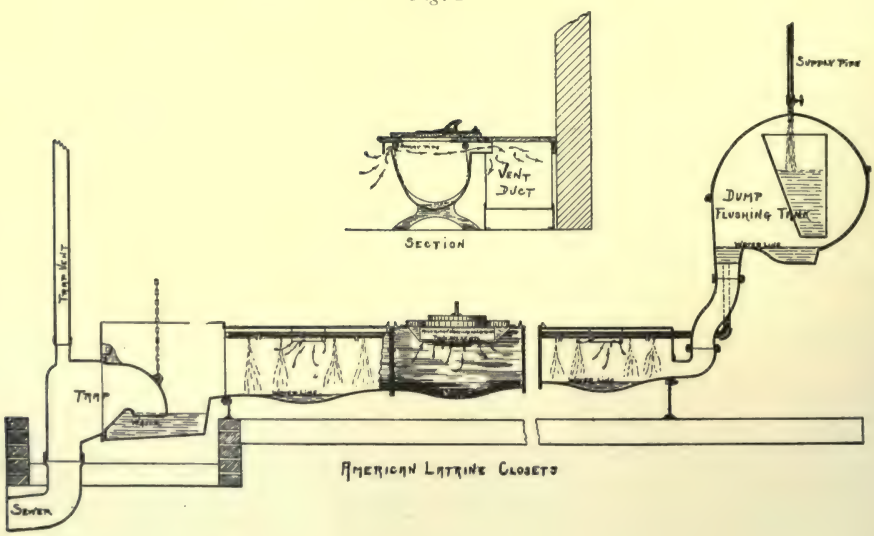
PLATE XXIV

Fig. 1



PLAN FOR OUT DOOR CLOSET

Fig. 2



American Latrine Closets

halls are wide and well lighted, and a wardrobe having both school room and hall entrance is provided for each room.

The heating of this building is with hot air indirect, supplemented by direct steam radiation. The writer is informed by the school authorities of Joliet that it is not wholly satisfactory in severe weather, and that in their newer buildings they use both direct and indirect steam radiation. In order to secure sufficient directness for the hot air as well as a sufficiently large heating surface, it was found necessary to multiply furnaces and to widely distribute them to different parts of the basement. A single boiler could accomplish the results easier and more economically by supply steam for indirect—supplemented by direct—radiation.

The advantage of steam over hot air in such a building is seen in cold and windy weather when the impossibility for hot air to make its way against a strong pressure on the windward side has been so often and so fully demonstrated that argument is no longer necessary. Were the Joliet building heated and ventilated by a steam plant properly installed, the writer would not hesitate in classing it as a model of its class.

Plates VIII and IX show floor plans, basement and sectional view of an eight-room primary and grammar school house which deserve careful study.

This plan is the result of an attempt of William Atkinson, architect, to plan a school house possessing all the necessary architectural and hygenic features at a minimum cost—"to reduce the cost to its lowest terms." To do this, Mr. Atkinson selects what is known as the "mill construction" which consists of exposed iron I beams and timbers; and inside walls finished with faced brick instead of lath and plaster.

As to the economy of "mill construction," architects in general do not consider it less expensive than that ordinarily employed. The writer's observation of its use in a portion of the manual training high school of Kansas City, Mo., is that it costs slightly more; however, this is excellent construction and is growing in favor as shown by many recently-

built houses in different parts of the country; it is strong, and being exposed the work must be faithfully done; it is especially recommended for laboratories and manual training workshops; it is "slow combustion" and when properly constructed looks well.

But it is not so much "mill construction" as other features which commend Mr. Atkinson's plan to careful consideration; its shape in simple parallelogram, and the small space occupied by halls are certainly elements of economy. The absence of a central hall makes it possible to heat and ventilate the house by means of one large chimney in the center and could be made a support for I beams if "mill construction" were used.

The position of the two halls confines the light to one side of the school rooms which are 24 ft. in width and 32 ft. in length. The five large windows evenly spaced and the proportion of the rooms makes the lighting ideal.

There are four well-lighted wardrobes on each floor, one for each room. Although these wardrobes are not in conjunction with the school rooms, they are near to them, and the inconvenience which their location would cause in dismissing the pupils would be small.

Another objection to the arrangement of the rooms is that all of the rooms cannot be reached from a common hallway, making it necessary to pass through certain rooms in reaching others. This is unconventional, but the objection is in reality insignificant when it is remembered that in a graded grammar school such passing is only occasional, and is chiefly confined to the movements of the principal in his visits to the different rooms; he could, when necessary, pass around on the outside.

We have now reached the proper place to consider the use of mechanical power as a means of ventilation. The necessity of this means in very large buildings is no longer a subject of debate, and is in use in all first class buildings in our large cities; but it is generally supposed that to buy an engine and fans for ventilating an ordinary eight-room

building would be an expensive luxury. This is not only an error, but it may be safely said that the reverse is true — that it is expensive to do without engine and fans.

It is now generally accepted that 2000 cubic feet of air at normal pressure is needed for each pupil per hour if the requirements of perfect ventilation are met; but the mistake is commonly made that this amount is ever realized in systems of gravity ventilation where the air is moved by heating aspirating chimneys. It is not denied that this quantity of air per pupil can be moved by the gravity method; only that it is not done in practice.

The most careful estimates place the amount of fuel necessary for this purpose as about one-sixth in excess of that required to supply the heating. So that to ventilate a building properly by the gravity method more than doubles the cost of heating without ventilation. It is plain that the burning of such large quantities of coal in chimneys for the purpose of ventilation is expensive and — in view of a better way — wasteful.

Without burdening the reader with deduction formulas, it may be reliably asserted that every pupil in school may be supplied for a whole school year with 2000 cubic feet of air per hour at a power cost of less than one cent *per capita*. As this statement will be reluctantly accepted by many who are unfamiliar with such matters, a few words of explanation will not be out of place.

It should be remembered that in securing this result the exhaust steam is not wasted but is admitted directly into the radiators and utilized for heating the building. The engine simply converts enough of the steam as it passes through into mechanical power to run the fans. The drop in the temperature of the steam which this change causes is very small, so small indeed that it might almost be neglected, and it is this drop which supplies the entire expenditure for ventilation.

In the complete combustion of a single pound of average bituminous coal, there is liberated 13000 heat units; multi-

plying this by the mechanical equivalent, 872, we get 10036000—the number of foot pounds of actual work of which one pound of coal is capable when the transformation takes place without loss; and this is precisely the case when a fan is run by an engine and the exhaust steam used for heating the building.

It will be interesting to note that this work, 10036000 foot pounds, when divided by 33000, the horse power per minute, gives 304 plus as the number of minutes one pound of coal will supply a horse power of work. One horse power is the work necessary to ventilate an average class room. We see then that one average sized school room can by this means be amply ventilated for five hours with only one pound of coal. At $4 per ton, this would cost one-fifth of a cent!

To move air at the same rate by burning coal in a ventilating chimney it would require for the same time an average of 100 pounds of coal; thus the cost of mechanical ventilation is only 1 per cent of that equally well done by gravity. To ventilate an eight-room building by mechanical means would require an eight horse-power engine and two three-foot fans. The cost of an installment would not exceed $350.

Twenty-one pounds per hour is the quantity of coal which careful estimates place as necessary to ventilate a school room containing 60 pupils. Now counting seven the number of fire months, 20 the number of days to the month, eight as the number of hours per day in which fire will be needed, $4 the price of a ton of coal, the cost of ventilating a building of eight rooms would be

$$\frac{7 \times 20 \times 8 \times 8 \times 21 \times 4}{2000} = \$376.32.$$

Any less expense would imply that the ventilation is imperfect and short of that which would be supplied by engine-driven fans. Thus, a power plant would pay for itself in one year in the saving of coal alone.

But there are other compensations incident to this system

in the installation. It should be remembered that all ducts, both for fresh and for foul air, need to be only half the size of those for gravity ventilation; this is because of a corresponding difference in the velocity of the air in the two systems.

Again, the indirect radiating surface is at least one-third less, due to the higher steam pressure which may be carried to supply the drop in temperature which takes place on radiator surfaces when strong currents are passed over them.

Taking, then, the great daily saving in coal consumption, the trifling extra expense of first installation, and the certainty of the action and efficiency of the mechanical method, what remains to be said? Simply that in buildings of eight rooms and upwards, mechanical ventilation should take the place of gravital. Whether we consider the matter from an hygienic, economic or mechanical basis, this conclusion is inevitable — a conclusion which has been amply verified by the writer in the Kansas City manual training high school during the past two years (Sept., 1897, to May, 1899), and to which fuller reference is made in subsequent pages.

THE LARGE CITY WARD AND GRAMMAR SCHOOL

As cities grow in population and as the price of ground increases until in extreme cases it becomes necessary to mass together 2000 to 3000 children under one roof, the problem of meeting all hygienic and mechanical conditions becomes serious and difficult. It is here that the factor of economy must in the main yield to necessity, and the enormous expenditure of money is one of the inevitable means of solution.

The only standpoints from which the discussion of economy has any justification in these gigantic structures is in the question of height and in that of architectural treatment for æsthetic purposes. And even this is scarcely allowable in great cities where the class of construction is practically forced by the surroundings and where a certain measure of beauty is demanded by the artistic spirit prevailing in met-

ropolitan "air." Notwithstanding that the cost per school room decreases with the number of stories, it requires with the best management about $5,000 per room to construct a building five stories in height in the city of New York. This is five times as much as would be required to secure conditions equally hygienic in the country, where the absence of plumbing and mechanical ventilation is compensated for in the unlimited playgrounds and free country air.

As to architectural effect, the writer believes that, considering the educational value of attractive surroundings and the relatively small cost of securing them when artistic skill is exercised, a due regard should be paid to the appearance of our school buildings.

When the architectural treatment is undertaken in a true artistic spirit — a spirit which makes art conform to utility instead of sacrificing it — the additional expense is well invested. It must, however, be confessed that there has been much useless expenditure in an attempt at meaningless ornamentation, resulting in a ridiculous exhibition of cheap filigree and hodge podge, devoid not only of the first elements of beauty, but often sacrificing utility and convenience.

The two extremes of expense in building a school house are found in the "factory" type, consisting simply of walls, windows and roof, without ornamentation of any kind; and in the "hospital" type, which comprises not only all modern improvements in sanitary plumbing, heating and ventilation, but architectural effect as well. When properly done, a sufficient architectural treatment can be given to a building with a moderate additional cost.

The following from Mr. Edmon M. Wheelwright, city architect, Boston, Mass., who has recently contributed to the "Brickbuilder" a most valuable series of articles on "The American school house," is so well said and so much to the point that the writer takes pleasure in quoting it:

"In designing a school house, the architect should strive to produce not an English college building, a French chateau, or a 'Romanesque' library, but a school house.

The practical requirements of the problem demand in most cases symmetry of plan, and in all cases lighting of the school rooms by wide and high windows. It is requisite that these windows should not have transom bars, and that either a flat roof or one of low pitch should be used. A high, well-lighted basement is also a requisite of a school house. The important rooms in the basement need ample windows, and a stud of ten feet is none too high for the proper installation of the heating apparatus. These requirements for the basement affect school house designing most radically.

"Such being the general requirements which most influence the general expression of our school houses, it will be found difficult to reconcile therewith features borrowed from the late English Gothic and the early English renaissance.

"Aside from economy in planning, which certainly leads to a balanced arrangement of rooms, the key to the external expression of a school house is the size and distribution and form of windows which experience has shown to be best adapted for the needs of a school room. This consideration of window treatment alone leads the architect who appreciates the economic and practical requirements of the problem to abandon picturesque treatments in a school house design and to adopt those suggested by the brick architecture of the Italian renaissance and by the Georgian work of England and this country. Sufficiently varied motives for the external expression of our school house plans can be found in these styles.

"* * * The architect to whom the designing of a school house is entrusted should accept the limitations imposed by the practical conditions of the problem. He should not seek to be 'original' or to gain the semblance of a structure, however beautiful in its own time and for its own needs, which does not meet the requirements of an American school house."

Mr. Wheelwright concludes that "under ordinary conditions, satisfactory architectural results may be obtained at an

access of cost of not more than 5 per cent above that of the most 'practical' construction."

Public school buildings No. 165 (Plate X), and No. 20 (Plate XIII) are given as types of large city buildings, not because they are considered perfect models of architecture and construction for buildings of their class, but because they are excellent buildings and have been erected under the most trying and extreme conditions in the crowded parts of America's largest city.

These buildings are heated by steam radiation and ventilated by engine-driven fans located in the basement.

A mechanical error has been conformed to in having separate engines for the different fans instead of deriving all the power from a single unit and distributing it to the fans by electric motors. A 50 h. p. engine with direct connected dynamo of 40 k. w. capacity and two 15 h. p. motors would be more efficient, more easily kept in repair, and more up to date than the old method of furnishing an engine to each fan.

It would also have been better to have divided the mechanical movement of the air between the plenum and the exhaust methods. The vacuum-forming tendency given by an exhaust fan is always effective and greatly assists the incoming air making its way against friction. And in cases when the room becomes too warm and the fresh air is temporarily closed off, the exhaust fan acts like a fireplace and can always be depended upon. The power required in the two methods is about the same.

In these New York schools, the air supply is estimated to be 1800 cubic feet per hour for each pupil.

In planning very large buildings, two distinct types are employed, known respectively as the open court type and the letter H type. As to which it is better to choose, depends on the size, shape, and location of the building lot.

The New York school, No. 165, is a good example of H type, which is for the majority of cases the better for crowded localities. In these districts, it is necessary to build

close up to the party line; this plan as seen in the present building makes it possible to build a solid blank wall on the party line with the windows all facing the open court which may be beautified, and the view is unobstructed by unsightly shops, smoky chimneys, and tenement houses.

The external treatment of building No. 165 shows an attempt to conform to the Gothic type of architecture. While utility has not, in this instance, been wholly sacrificed, and making due allowance for differences in taste, the writer is of the opinion that the high pitched roof, the pinnacles, and the pointed dormers are not the most appropriate form of decoration. The architect, Mr. C. B. J. Snyder, justifies the space occupied by the roof by using it for a gymnasium and for vent flues.

The building laws of New York require such a great thickness of wall in high buildings that much valuable space is gained in buildings over four stories in height by using the steel skeleton type used in the large office buildings; this makes it possible to reduce the thickness of the first story walls from 36 inches to 16 inches.

The introduction of manual training into the schools of the United States has been met in school house building by placing it in different parts of the house, from the basement to the attic. In building No. 165, the whole fifth floor is given over to manual and physical training and a gymnasium.

As manual training in grammar grades is still in a transitory and unsettled state, the provisions for it in school house building are as various and imperfect as is the knowledge concerning its place, amount, and nature in the course of study. In high schools, certain requirements and methods have become established making more clearly definite the functions of the buildings, as is pointed out further on.

There is a difference of opinion as to the necessity of an auditorium in a grammar school. In New York city, a demand for an audience room and a regard for economy are two conflicting ideas which seem to have met and compromised as shown in building No. 165 in sliding door par-

titions between all the rooms on the second floor of the central pavilion. An auditorium or general assembly hall in a primary and grammar school is of doubtful utility so far as the management of the school is concerned.

The lighting of building No. 165 is generally to be commended. All the rooms except those in the ends of the outside pavilions are lighted on one side only, by three very wide mullioned windows occupying nearly the whole inside wall space. It may be said of the end windows that they are objectionable if the rooms are to be used for ordinary class purposes. By using these ends for wardrobes, the windows would not interfere with the requirements of hygienic lighting and might still be left to furnish a justification for the pretty Gothic window at the top.

A difference of opinion prevails among the leading architects of this country as to the form and position of windows. Mr. Wheelwright objects to the use of mullions and transom bars, while Mr. Snyder in his best New York buildings makes free use of both. The objection to mullions is based on the uneven distribution of light which is incident to unequal spacing. This, however, depends on the conditions in each instance. There appears to be no objection to mullions as used in the central pavilion of building No. 165 where the rooms are lighted on one of the shorter sides and the windows, whose frames are 17 ft. in width and 11 ft. in height, occupy nearly the whole of the available wall space; but in rooms lighted as they should be on one of the longer sides better results can be attained by plain windows evenly spaced than by any use of mullions. The use of them, then, in school house building should be limited to those exceptional cases which require practically the conversion of one side of a room into a single, unbroken source of light.

The use of transom bars, however, cannot be defended, for they are obstructions to light and are certainly not justified if their only purpose is conformity to ancient ideals which had purposes of their own quite different from those

demanded in a school house. The highest art will give a pleasing expression to the highest utility.

In determining the ideal length for a school room, the two main considerations are the distance which an ordinary conversational tone of voice will carry, and the distance at which ordinary blackboard writing can be seen. This distance may be taken, with liberal variations to meet particular cases, to be about 32 feet.

The width will depend on the height of the windows. If the German standard of requiring the width to be not greater than twice the clear height be accepted, then the width of the rooms in building No. 165 might be 28 ft. 6 in., as the height is 14 ft. 4 in. A room 28x32 ft. will comfortably seat singly 56 pupils. This is as many as any teacher should be called upon to manage in one room.

In determining the size of classes, there is somewhere a proper balance between the economic and the pedagogical phases of the question. As the child is the all-important factor, it would seem that the maximum number of pupils which can be admitted to one room without sacrificing their health or individuality should be first determined and then make the school house conform to the requirements. As the limits of safety are not confined within fixed, hard and fast lines, the writer believes that the limits of hygienic teaching can be found in a room varying between 22 to 28 feet in width and 30 to 36 feet in length, accommodating respectively 40 to 60 pupils according to conditions.

The mistake in school house building has been in making rooms too large instead of too small as is sometimes charged. The answer of Superintendent Philbrick of Boston, Mass., to this charge when made some years ago against the size of the rooms in the English high school of Boston which was planned by him is worth repeating: "It has been said that the rooms are not large enough. One might as well say that a bushel measure is not as large as it should be. The rooms are as large as they need be for the objects in view in planning them."

In planning a school house the number, size and position of the rooms should first be determined and the architecture adapted to the requirements can then be selected. But the architect too often first decides upon the outside appearance and then makes the interior arrangements to fill the spaces; this frequently results in rooms of various shape and size not well adapted to the purposes for which they were intended.

One of the most important matters in large primary and grammar schools is the number and location of the wardrobes. The provision for these in building No. 165 are not satisfactory. For purposes of order and convenience in handling large numbers of small children there should be one of these cloak rooms provided for each school room. In the building under consideration there seems to be no provision for these rooms in the central pavilion, and those in the outside pavilion are not lighted. This defect could have been corrected by placing windows in the blank wall on the property line. Such windows, notwithstanding their proximity to neighboring walls, would, if ground glass were used, serve a purpose in lighting these cloak rooms without opening a view to objectionable neighborhoods.

A provision for an amply lighted cloak room for each school room is shown in fig. 1, Plate XII, which the writer suggests as an H plan for a large primary and grammar school house. In this plan it is assumed that the building occupies one-half a block having streets on three sides and an alley on the other. In many available sites this condition can be secured; but in cases like that of the New York building the position of the corridors and school rooms in the outside pavilions could be reversed without organic change in the design. In this plan the following features are secured: 1. Ample shelter for 2000 to 4000 pupils, according to the number of stories; 2. Rooms 24x32 ft., the proper proportion; 3. Ventilation by combination of plenum and vacuum movements as shown by the number and position of flues; 4. Four large windows in one

side provide ample light for the school rooms if the clear height is not less than 13 feet; 5. A well-lighted cloak room opening into each room and into the corridor, which serves ideal convenience in dismissing the pupils.

This plan does not preclude the use of the space here shown from being occupied by school rooms for other purposes which local conditions might require, such as offices, reception rooms, water closets, play rooms, etc. The plan is intended to suggest a way to secure the above-named features for every school room, and the arrangement would conserve equally well the lighting, warming and ventilating requirements for whatever use the space might be employed.

The position of the cloak rooms at the ends of the outside pavilions while unconventional, serves to preserve the intent as to side lighting, while it does not preclude any outside window arrangement which architectural treatment would necessarily require. Fig. 2 illustrates the idea when applied to a smaller building.

With the limited opportunities in the densely populated districts of our large cities for exercise in the open air, the question of play grounds becomes important. In building No. 165, the open courts between the outside pavilions not being sufficient, the whole first floor is given over to this purpose. This is unnecessarily expensive. The prejudice in New York city against any use of the basement except for the heating and ventilating apparatus should give way before the light of modern methods for the sanitary regulations of basements. A properly constructed basement with half-height top windows and properly supplied with fresh, warm air is as wholesome as any room in the building.

It is especially important in providing for a system of ventilation to carry the air from an elevated and pure source instead of taking it from back alleys and beneath porches and door steps as is too frequently the case.

The use of the roof for play grounds is a good solution of the problem. Public school No. 20, New York city, Plate XIII, is a good example of this use of the roof. The

air at this height is generally pure and the sunlight is unobstructed. By thus utilizing the roof and dispensing with the waste space of a high attic under it, this scheme is advisable from an economic as well as from an hygienic standpoint.

THE HIGH SCHOOL BUILDING

A study of the high school buildings of this country reveals perhaps more than do buildings of any other class the progress not only in school architecture but in pedagogical methods as well. From the first conception of secondary education which consisted of adding four more to the eight primary and grammar grades, the high schools have developed a system of specialized work which is expressed in a building planned and equipped to meet the many and diverse requirements.

The first high school building which marked distinctively an epoch in school house architecture in this country was the Latin and English high school of Boston, Mass., which was begun in 1877. This house was planned by Mr. Jno. D. Philbrick, then city superintendent of the Boston schools, and Mr. Clough, the city architect. The plan was inspired chiefly by Mr. Philbrick after a study of the celebrated building in Vienna — the Academische Gymnasium — which is probably the best school building in the world.

The building is a pure type of the court plan and covers a block of ground 423 feet in length by 220 feet in width. The rooms and corridors are arranged in parallelogram form around a central court which admits light and provides a playground. The lighting for the school rooms is taken principally from the street sides.

This building marks several interesting transitions in methods and ideals of education, one of which is shown in the large military drill rooms, 30x62 ft., a reflection of the militant type of European education. Another is the amphitheatre style of "lecture" room for the teaching of science instead of the working laboratory method now in vogue in the best schools. True, this building contains a

working laboratory, but the dominant feature in the science work of that time is seen in the care and expense lavished on the lecture rooms. The building reveals a curious intermingling of the ordinary graded high school, a military academy, and a college of the conventional type.

But it is not for the purpose of calling attention to its faults that this building is here referred to; in many important particulars it may stand as a model of the best that has yet been realized. In the mattter of size, form, location, and lighting of its 48 school rooms it undoubtedly stands at the head of American school houses. Other houses with more modern characteristics have in these important features not preserved the perfect model which this building furnished. These class rooms are of the ideal size and shape, 24x32x14 ft., and lighted by four windows, 9 ft. 6 in. x 4 ft. 6 in., placed on one of longer sides six inches from the ceiling and four feet from the floor. They will accommodate from 35 to 40 high school pupils seated at single desks.

Another excellent feature of this building is the arrangement of water closets, which occupy positions in wings from the stairways, there being two stories of them for each floor, one of the stories being entered at the half-way landings between the floors.

The building is not sufficiently ventilated, there being allowed but 800 cubic feet per hour for each pupil, instead of 2000 cubic feet which is now considered necessary. There also seems to be little or no provision made for the care of the pupils' wraps, except some low box-like closets under the windows, which proved entirely unsatisfactory.

The building was intended to be fire-proof, the corridors being constructed with iron beams and brick arches plastered upon the bricks; the floors are of black marble; and the staircases built of iron.

The main idea which dominated the minds of the designers of this building should not be lost sight of: that the real width of any organic part of the house should be the

width of one school room plus the width of the parallel corridor. Whether the construction be on the court or the H plan, this principle is sound, and should be rigidly adhered to in planning a very large school house.

One of the essential features of a high-school house as it differentiates from one built for grammar school purposes is the assembly hall, which in America is simply a large school room intended for general purposes of classification, and the assembling of the school as a whole for general instruction, announcements, opening exercises, musical entertainments, lectures, etc. It is not an imitation of the German Aula, which is largely for general public purposes, and is usually richly ornamented with costly architectural treatment. The American high school assembly hall is strictly for utilitarian purposes, and not "to represent the dignity of the state." In the Boston school there are two assembly rooms, both on the third floor in the central pavilion, each capable of seating 800 persons. The purposes of the school would have been better served had these halls been united into a single room capable of seating the whole school. But here again the building represents another transition in high school development, that of separating the "classical" and mathematical from the English and science branches; indeed, the block is divided into halves, one for the former and the other for the latter branches. These two assembly rooms were probably intended for the two schools.

The Cambridge English high school (Plates XIV and XV) may be taken to illustrate the next important step in the development of secondary education in this country. The recognition of natural science to a place in the curriculum came slowly, and the pursuit of it by the working laboratory method came still more slowly. In this building, ample provisions have been made for physical and chemical laboratories in two of the large corner rooms on the second and third floors.

These laboratories are well equipped with demonstration tables, chairs with writing-arm attachments, working desks

plumbed for water and gas, shelves for reagents, and gas hoods in the chemical laboratory for the removal of noxious gases.

The building represents what may be called the physical science stage in high school development where physics and chemistry have secured their rights, but where the biological sciences — botany, zoology, and physiology — are still in the show cabinet stage, no provision being made for working laboratories for them.

The building is constructed on the H plan with the end pavilions short. The corner rooms are well adapted for the laboratories and drawing rooms, which need an abundance of light and in which light from more than one side is not an objection.

Six of the corner rooms are used for class rooms — a use which does not show an ideal adaptation, as they are 40x 28 ft., which is too large for the purposes of instruction; it is presumed, however, that they are used to accommodate pupils who are studying as well as those who are reciting.

A more recent and a better method of providing for the study periods of the pupils is the seating of them in rooms or "study halls" planned for that purpose. In modern high schools, the pupils change places every period as is the custom in colleges. These corner class rooms in the Cambridge building are too large for class rooms and smaller than they should be for study rooms as a teacher can easily manage from 100 to 150 pupils in the study hall; they serve to represent that phase in school house building before the function of a room for recitation and for study purposes became differentiated.

The large assembly hall and the drawing room on the third floor are well adapted to their uses, and the large room in the center pavilion on the second floor called the "senior class room" would make an ideal freehand drawing and art room.

The number and position of the wardrobes ("coat rooms") is ideal from the grammar school standpoint; in

high schools, however, of more recent construction, these rooms have been left out, and the wraps of the pupils disposed of in individual lockers placed in large rooms in the basement set apart for that purpose. This differentiation from the grammar school plan, besides being economical, presupposes that the age of high school pupils puts them beyond the necessity of individual espionage while being dismissed.

But the most distinguishing characteristic of the Cambridge building is its external appearance, it being the first building in which a rational and artistic treatment and utility were happily combined. When visiting this building in 1896, while making an extended tour of school house inspection, the writer was impressed with the simple, strong, artistic elegance of its architecture. It is well proportioned, its parts well unified without any attempt to obscure the uses for which it was intended; and it is free from fussy, meaningless ornamentation. It stands for what it is — a beautiful school house. By referring to Plate XIX it will readily be observed that these characteristics are reflected by the manual training high school, Kansas City, Mo., started in 1897.

The Cambridge building was erected without special regard for economy; it is fire proof, and built of expensive material; the basement is granite, the first story Amherst stone, and the second and third of terra-cotta brick; its cost, exclusive of ground, was $230000.

While this building stands as an architectural unit from a high school standpoint, the course of study pursued in it is unified with the manual training school, which is situated on the opposite side of the beautiful grounds donated by Mr. Frederic H. Ringe.

The new high school building at Springfield, Mass., Plates XVI, XVII and XVIII, is given as representing the last step in high school development preceding that of the manual training high school. It exemplifies not only what can be done when economy is not a restraining factor, but

also illustrates the prestige at which secondary education has arrived in this country. From architects who have $300000 at their command, exceptional results are naturally expected. In the Springfield building, which cost somewhat more than this amount, while not above criticism, our expectations for excellence have in the main been met.

The external architectural design is based on the Italian renaissance, and while it lacks the harmony of proportion given to the Cambridge building, it is strong, dignified and chaste. The foundation walls above grade are of pink granite; the walls of the other stories of buff brick, and the trimmings are of Bedford limestone. Every sixth course of brick of the first story is indented ("six cut work") which adds variety and strength to the general effect. It is constructed on the central court plan, the rooms occupying three of its sides, and a corridor completing the rectangle. It is 203 feet by 173 feet, and built on a lot 400 feet by 270 feet.

The interior is rich with all the ornamental detail which polished marble, plate glass, bronze trimmings and other expensive materials can give. Mechanically it is a modern, expensive and magnificent structure.

The heating is by indirect radiation supplemented by direct radiation in exposed parts. The furnace and boiler are installed in a separate house outside the main building. This feature is much to be commended as it insures to all the school rooms immunity from coal dust and escaping smoke which are incident to a boiler house even with the most careful firing. This plant has four horizontal tubular boilers each 125 h. p. capacity. The indirect coils are located in heating chambers near the four outside corners of the building. The fresh air is supplied to these heaters through main conduits extending around the parallelogram directly under the corridor of the first floor. These conduits are very large, about 80 square feet cross sectional area insuring an abundance of fresh air. The air enters this conduit through an elevated shaft — a highly commendable sanitary feature — by which a pure source is insured.

The plenum movement is accomplished by three large fans located at convenient distributing points. The four exhaust fans, four feet in diameter, are located near the top of the four vent shafts. Separate fans are used to ventilate the laboratories.

The heat is regulated by thermostats, another luxury of modern engineering. This is in reality more than a luxury in a school house; it is a necessity, for experience has proved that the regulation of the heat in school rooms cannot safely be entrusted to the teachers, whose minds are not only preoccupied but whose judgment on such matters is not always to be relied upon.

The lighting of this building, while in the main abundant, is not altogether fortunate in its distribution. The assembly hall in the center of the court is lighted from above and by light courts at the sides. The school rooms on the sides of the building are large — 27 feet by 37 feet — well proportioned and well lighted by five windows on one of the longer sides; but the eight corner class rooms on the first and second floors have the objection common to such rooms used for this purpose — light in the face of the teacher. This defect is not necessarily incident to the court plan of construction, and has been happily avoided in the Newark, N. J., high school, Howard & Cauldwell, architects. Although the advantage of light on two or more sides for laboratories is not recognized in this school.

It is the character and arrangement of the third floor of the Springfield building which especially commends it as a type of modern high school building. Here the recent demands of the physical and biological sciences are fully met, and the relative importance of laboratory and lecture work properly apportioned. The whole provision on this floor comprises seven working laboratories, three drawing rooms and one lecture room. The latter occupies a central position between the chemical and geological laboratories on the one hand and two physical laboratories on the other. The biological laboratories — three in number — occupy

positions on the side of the building adjacent to the physical laboratories; and the drawing rooms are located on the remaining side. The drawing room on the corner, with light on two sides, is adapted to mechanical drawing, while the long room, lighted on one side by seven windows, is admirably adapted to freehand, perspective and art work.

A conservatory for plants and flowers is situated on the third floor on the inside of the corridor extending into the court. Above this is an astronomical observatory with revolving copper dome.

But it is in the location and height of this observatory that the enthusiasm of science has somewhat strained architectural possibilities. While the dome is a very good one and looks well when viewed at some distance, it is practically useless for astronomical purposes except for amateur work of the crudest kind. Although "it rests upon a steel column directly connected with one of the foundation walls," vibrations are certain to occur on account of its height and its connection with the roof of the building. The writer speaks from experience with a telescope similarly located in a dome above the third floor of the Kansas City central high school.

In the disposition of the pupils' wraps, the grammar school characteristic has been retained. Wardrobes are located in a quarter without light between the corridors and the school rooms, instead of having individual lockers in large rooms in the basement, as now found in many high-school houses of recent construction.

An excellent use has, however, been made of the central space in the basement of the Springfield building. A large lunch room is here provided with double counters equipped for furnishing light refreshments.

The question of lunches is one of the important and unsolved hygienic problems in high school education. This problem arises from the relatively short school day in secondary schools; it is too long for one session and too short for two. When put into one, the dinner hour is too late; when divided into two, the short cold lunch hastily eaten is

equally objectionable and detrimental to the health of the pupils. A large, well-appointed cafe in the building, where it can be secured and managed economically for the pupils, is the best solution of the problem. This gives two short sessions, with a light warm lunch given at the proper time.

THE MANUAL TRAINING HIGH SCHOOL

It has been noticed that the high or secondary school in America started simply as additional grades to the eighth grammar grade; and that these grades confined the attention of the pupils to books only, differing from the work of the lower grades only in the subject-matter found in them. We have seen the school house for this work grow from the ordinary school room type to that just described.

No less interesting is the growth of the manual training high-school house which is as in the former case a material expression of educational progress in this country.

With the growth of the high school and the multiplying of branches of study, came a tendency too scholastic and bookish for practical purposes, when science came in as a balance. But laboratory science, excellent as it serves its purpose, is inadequate. The applications of science to the world of industry and art is not made a part of the pupil's growth until he can make this application a part of his training.

The first response to this demand for the practical element was, as in the case of the high school, crude. It was merely a better sort of apprenticeship — a trade school. Later, a little academic work was added — just thrown in for "a little book learning." Still later the use of tools was generalized, the academic requirements enlarged by the introduction of branches of high school grade. The curriculum was adapted to pupils of high school age. The time was divided between tool work, drawing, and book studies, and the "manual training high school" became a reality.

It would be interesting to trace the growth and development of these schools by giving plates from the first one

which was built in St. Louis twenty years ago under the direction of Calvin M. Woodward, and still a flourishing school, to the latest and most improved; but space forbids. The first of these schools were supposed to be for those who expected to be mechanics and were for boys only. It was not till the establishment of the St. Louis school that manual training was considered on an educational basis.

With the recognition of the educational claims of manual training, apart from its practical utility, came the apportionment of the academic studies and tool work in making out the curriculum. In doing this, varying knowledge and conflicting ideas have been crystalized and recorded in the school houses. In some cases, one or two shops were added to the ordinary high school where the boys could work "after school;" in others built for manual training schools, the shops predominated, and the mere mechanic fixed the character of the school with too few of the academic characteristics.

Later came the extension of the manual high school to girls, and the modification of the training answering to their needs along the lines of the feminine industries; and this correlated with the full academic, art and science provisions of the ordinary high school.

Thus have the two types of school — the purely academic and the purely mechanical — grown, developed, and converged into one correlated unit forming the high school, par excellence. The term "manual training," which at first had its uses in distinguishing two distinct types has become somewhat misleading in its application to the school of to-day; but it must still be retained for the want of a better means of designating it from those high schools which have not yet incorporated manual training into the curriculum.

The Kansas City manual training high school, Plate XIX, is here given as a type of its class, not because it is in all respects superior to others or because it is free from defects, but rather because it was planned after others had been carefully studied.

The public manual training high school building of to-day should embody in its construction rooms specialized for a four years' course in art, science, academic work, and manual training for boys and girls; and owing to the expense of maintaining it above that of the ordinary high school, its construction should be undertaken with the strictest economy consistent with hygienic and architectural requirements.

The writer believes that more of these requisites have been realized in this than in any other school house yet built. When finished (the east pavilion completing the design as shown is now, December, 1899, nearly completed), it will be 190 feet in length and 140 feet greatest width; it is built on a lot 250 feet long by 165 feet wide, and has a frontage on three streets.

The central and right hand (as shown by the cut) pavilions were built in 1897 at a cost of $100000; this includes heating, ventilating, plumbing, laboratory, equipment, furnishings, and manual training equipment for first two years of the course, but not the ground. The wing now being built will, with its equipment, cost $50000 more, making a total of $150000 for the entire plant. The basement walls are of limestone blocks rough hewn and "pitch faced." The upper stories are of Kansas City buff brick, the first story being "six cut" work. The roof is of brown slate. The architectural effect is pleasing; it is plain, straightforward, and free from meretricious ornamentation. Flamboyant trimmings are absent. Something of the harmonious effects which have been noted in the Cambridge high school have been given to this with less expensive materials. The arches which span the piers between the windows of the second and third stories of the central pavilion, while suggested by the Romanesque style of architecture, do not sacrifice the lighting of the rooms, for the mullioned windows as here employed give a larger opening than could be otherwise secured. But the transom bars used in these windows should have been omitted, for they obstruct light and do not improve the appearance.

The heating is accomplished by indirect, supplemented by direct, steam radiation; the ventilation by two Hope propellers, 6 ft. in diameter, one in the fresh air room serving as a plenum, the other in the foul air room as exhaust.

The chief merit of this lies in the central location of the plenum containing the indirect steam coils. The arrangement is shown in the basement plan; the plenum is the unlettered room in the center. A change was made in the plan which makes the plenum room slightly smaller than represented. This room with its heated steam coils and fresh air supply are to the buildings what lungs are to an animal, and its location in the center insures a balanced circulation. The movement of the air is as follows: The plenum fan located in the fresh air room receives the supply through vertical shafts on either side of the front entrance. The openings into these shafts are the large louvre windows shown in the perspective, Plate XIX. These windows are on the north side of the building far removed from any source of smoke and high enough from the ground to insure purity. The course of the air after it is forced through the plenum room may be followed by referring to the cross section of the building, Plate XXII. The section is made through the fresh air, plenum, and foul air rooms and shows the position of both fans. The air rises through the fresh air flues and is delivered into the rooms about 8 ft. from the floor. It is drawn out by the exhaust fan located in the foul air room through the foul air flues which lead from the wall registers near the floor to a sub-basement shown in fig. 1. This sub-basement is three feet high and extends the entire length of the building the full width of the bicycle rooms; four wings extend from this subway so as to communicate with the four sections of flues between the rooms. The exhaust fan draws the air from this subway, thus connecting the lower registers of every room with low pressure.

It would require a longitudinal section of the building through the bicycle rooms to illustrate the movement of the air toward the outside pavilions: but this is easily described,

A "false" ceiling three feet below the floor over the bicycle rooms provides an open free passage for the air as it is forced from the plenum room; this is virtually an extension of the plenum room to the openings to every fresh air flue in the house without the use of distributing pipes.

By this means, all the friction which is incident to the usual method of pipe distribution is eliminated. This being a departure in pneumatic engineering, it deserves some attention; it was a concession on the part of the architect and the result of a compromise with the writer who wanted to extend this plenum chamber in the same manner beneath the floors instead of near the ceiling by the conventional method.

Let it here be noted that the economy in fuel when warm air is delivered through the floors and so distributed that it may be let out at the ceiling is enormous. It exceeds the usual way by a ratio almost equal to that of the mechanical system of ventilating over that of the gravital noted on a preceding page.

The economy in warming when the air is properly distributed through the floors and let out at the ceiling, as compared with the conventional way, has been carefully tested by the writer by the use of an experimental model. While these experiments are somewhat too technical to suit the purposes of this article, a study of the plot, Plate XXIII, will not be without interest.

The figures at the left show the difference in inside and outside temperatures; those at the top, amperes of electric current used in heating iron coils as the source of heat; those at the bottom, relative heat units. It will be noticed that these are the squares of the amperes above and thus show the well-known thermal relation between the current and its thermal equivalent. It will be understood that these numbers are not real thermal units, but serve to show the relative amount of heat at different readings of the ammeter.

The line AO shows the results when the air was distributed under the floor with ventilation above; BO, when the

air was delivered at the side with ventilation below; CO, when the air was delivered near the top and let out at the top. Take an example: Suppose the temperature above that outside of the room to be 50 degrees, this temperature line crosses the resultant line at X, showing that it requires 2 1-2 amperes of current to maintain this temperature when heat is applied below. With the same temperature when the heat is applied at the side the line crosses at B, showing 10 amperes. Whence it is plain that the relative heat required in the two cases is shown by the ratio of 6 1-2 to 100. In plain words, it would require only 6 1-2 per cent of the cost by present methods to heat a building if the air were properly distributed, delivered through the floors, and let out at the top.

The writer fully realizes that the foregoing brief statements will be somewhat unsatisfactory to those who are unfamiliar with the details of the tests,[1] but he is confident that this method of warming and ventilating has reached the stage of successful experiment, and will as surely displace the old way as that the electric motor displaced the horse in street car locomotion.

Returning to the extended plenum chamber under the corridor floors, it may be said that it works perfectly, and so much of the "theory" has passed into history.

During the first two years of its use this system, with the exception of the register in one room, has required no regulation of the registers, notwithstanding the absence of thermostats. The exceptional room is on the first floor just opposite the plenum fan; in this the delivery is excessive unless the register is kept partly closed. The exception is of so little importance, however, that the placing of a deflector in the plenum room has not been found necessary.

While the ventilation of this building has some of the defects common to current practice, the writer believes that

[1] For full explanation and experimental details of these tests, see the writer's paper in the Report of the Proceedings of the Mechanical Engineering Section, American Association for the Advancement of Science, at Columbus, O., 1899.

it is the best ventilated school house in America, and, the size of the building considered, the most economical.

The fans, when running at full speed, 400 revolutions, move 60000 cublic feet per minute. This would supply 2000 pupils each with 1800 feet per hour. The average daily attendance during the past year, 1898–9, was about 900. The fans were run 250 revolutions per minute giving each pupil 2500 cubic feet of pure warm air per hour.

The lighting of this building is nearly ideal. The H plan of construction provides light on three sides of all rooms used for laboratories, manual training and mechanical drawing; including the lunch rooms and the engine room in the basement there are 16 of these. The large windows at and above the three main entrances furnish ample light for the halls and corridors. The class rooms do not conform to the ideal standard recommended in the preceding pages. These rooms, while of ideal shape and size, are lighted on the shorter instead of the longer side. But considering the use of the entire available wall space which has been employed for the mullioned windows lighting these rooms, the height of the rooms being 14 feet, and the use which is made of the rooms, this departure from standard requirements is not serious. It should be remembered that in high school academic work there is comparatively little pen-writing done, the greater use of the eyes being confined to blackboard work. The light in these rooms is ample for all purposes for which they are ever used.

The assembly hall is as light as day itself, as may readily be inferred by glancing at the third floor plan. With ceiling 24 feet high, and light from 18 large mullioned windows 8 feet by 16 feet with arched windows above these, entering from opposite sides, more light is provided than is called for by any standard. This assembly hall is 120 feet by 84 feet and has a seating capacity of 1600 persons; it serves for lectures, concerts, study hall, and commencement exercises. It is equipped for stereopticon projection work; and although there is a window area of 2800 square feet, the room is com-

pletely darkened in 50 seconds by an automatic electrical device which controls the raising and lowering of the darkening shades and the screen back of the platform.

It may be noted here that provision for darkening rooms for scientific purposes and for illustrated lectures is another phase of modern school architecture, and not until recently have the mechanical difficulties incident thereto been entirely overcome. The mechanism in the Kansas City school consists of a 1 h. p. Westinghouse motor with worm gear, magnetic clutch, and drum attachment which moves a steel cable extending around the room under the windows and beneath the floors.

The physical and biological laboratories provide for teaching physics, chemistry, botany, and zoology, and all have separate teacher's laboratory for research work. The working tables in the physical laboratory are each separately wired for the individual use of the current by the pupils. The brick pier (shown in the plan of the girls' lunch room) terminates in the physics demonstration table furnishing a vibrationless support for galvanometer experiments.

The chemical laboratory is furnished with students' working desks with solid slate slab tops. Six drawers to each desk provide a locker for each pupil in which to keep apparatus for which he is alone responsible. Three large gas hoods located against the walls and in communication with the exhaust fan give perfect ventilation and provide a place to generate noxious gases. Another point of special convenience in these laboratories is the sliding door 16 feet wide which throws them together with the adjoining large class rooms. By this arrangement, the teacher may oversee a laboratory division while conducting a recitation.

The tables in the biological laboratories are topped with plate glass which has the advantage of smooth, easily-cleaned surface for dissections. Wall paper of a neutral tint placed under the glass relieves the eyes of the pupils. The main corridors on the first and second floors are 19 feet wide and serve the double purpose of corridors and exhibition halls

where at the closing week an exhibit of the yearly work is arranged on long tables.

The large "geology and natural history room," on the second floor will hereafter be used for a free-hand drawing and art room, the north light making it ideal for this purpose.

The pupils' wraps are provided for in locker rooms in the basement.

The outside pavilions are of the "mill construction" which is especially to be commended for shops and laboratories. The inside walls are of pressed brick. The floors are supported by large steel I beams running crosswise, carrying large, finished, wooden joists. One entire pavilion is used to accommodate the manual training work; while architecturally a unit with the other part of the building, this pavilion is set off by an independent wall with a 4-inch cushion of air between to prevent the communication of vibrations to the class rooms from running machinery. An additional precaution is furnished by the intervening locker and wash rooms which serve the boys in preparing their toilets after the shop exercise.

The entire inside finish is of selected yellow pine. The building is not fireproof, except the "slow combustion" which the mill construction secures to the parts just mentioned. The isolation of the building and a system of night-watch signals make fireproof construction unnecessary.

The numerous class rooms supplementing the laboratories, shops, drawing and art rooms provide conveniences for a complete high school academic course correlated with laboratory science, manual training and drawing.

The stairs in this building conform to the standard requirements as to number and height. The double staircases at either end of the main corridor and the single one at the end of the central hall afford ample and free egress in case of fire. The stairs are five feet in width with six-inch risers and twelve-inch treads.

While the injury to the American school girl from stair climbing has probably been exaggerated, it is undoubtedly

true that girls of delicate organization have suffered much from this cause. It seems to be the consensus of opinion of all who have considered the subject that the six-inch riser and twelve-inch tread makes the easiest stairway. There should not be more than fifteen stairs between landings.

CLOSETS

The location of closets should be determined by the existing facilities for ventilation and drainage. Where there is any doubt as to the efficiency of either, closets should be placed in outside buildings; but when a school house has the advantage of good sewage and mechanical ventilation, the place for pupils' closets is the basement.

The condition of closets and outhouses which usually prevails in districts without sewage deserves the severest criticism. It is here that the results of ignorance and carelessness are fully revealed. The privy vault should never be tolerated, and the large receptacle surface tanks which are usually "cleaned" two or three times a year are little better. The following quotation from the report of the state board of health of Maine for 1892–3 is good, and covers about all which need be said of outhouse closets: "All that is needed is a common closet, a supply of dry earth, a water-tight receptacle beneath, and a convenient way of disposing of its contents at quite frequent intervals.

"The receptacle should be wholly above the surface of the ground, and may consist of a metallic-lined box, a half of a kerosene barrel with handles upon it for removal, or, which is better, a large galvanized iron pail.

"The receptacle may be removed through a door in the back of the closet or in front of the seat, or, by having the seat hinged and made to button backward, it may be removed that way. The earth should be common garden or field loam and finely pulverized. Road dust does well, but sand is not suitable. Coal ashes are good. Whichever of these is used should be dry and screened through a sieve with about quarter inch meshes. The dry earth may be kept in

a box or bin so arranged, where it can be, that it may be filled from the outside of the closet, or it is quite convenient to have one-half of the seat hinged, and beneath it the small compartment to hold the present supply of the earth. In this box or bin holding the earth there may be a small tin scoop which may be employed in sprinkling in the earth, a pint or more each time the closet is used. The main thing is to use enough of the earth to completely absorb all liquids, and this requirement, of course, precludes the throwing of slops into the closet."

Figure 1, Plate XXIV, shows the construction of this closet.

Arrangements could easily be made with gardeners or farmers for the daily removal of the contents of these receptacles for fertilizing purposes.

Closets under the roof of the school building should have good sewer connection through a heavy cast iron soil pipe which should have a vertical extension in a pipe 3 or 4 inches in diameter through the roof for ventilation; an efficient trap situated in a convenient manhole; an automatic flushing tank, and local ventilation for each separate seat.

It is important that provision be made in school house closets against the stopping up of pipes and traps, and the neglect incident to hand flushing, hence automatic latrines are preferable to single closets. The mechanical conditions of a perfect system of closets may be studied by referring to the cut, Fig. 2, which shows a longitudinal section of the automatic flushing latrine in the Kansas City manual training high school.

It was installed by Lewis & Kitchen of Kansas City. The trough is made of cast iron lined with heavy enamel and is perfectly smooth and durable. The bottom is so constructed that the water stands only in the parts of the trough directly under the seat. The trap is the invention of J. H. Brady, engineer for the Kansas City board of education; it is hinged so that it may be raised up allowing all accidental lodgements a free exit; it is located in the bottom

of a dry vault and may be reached with a hook in the hands of the janitor or other person. There is no possibility of needing the services of a plumber should the trap become clogged.

The upper drawing in the cut shows the local ventilation of each separate closet. The air enters just below the front part of the seat and passes out at the back into the vent duct which is in direct communication with the exhaust fan. The ventilation in this method of transverse movement of the air is better than it is possible to secure in systems which ventilate the trough longitudinally, for even when the lids of the seats are left down the air passing under them from above will supply the current and prevent the requisite flow from the end of the trough remote from the vent.

The boys' urinals are of the stall partition type with gutter trough ventilated at the bottom. The back, ends and partitions are made of hammered glass, the tread and trough being of slate. Glass is preferable above all other material for this purpose as it is easily cleaned and free from any tendency to disintegration.

NORMAL SCHOOL AND COLLEGE BUILDINGS

The essentials of a normal school house are not materially different from those of a first class high school. Class rooms of ordinary typical construction serve the purpose of "professional" work with training classes, and with modern views now taking root respecting the amount of academic, science, and manual training needed in normal school courses, these functions have already been considered in describing the manual training high school. The "Teachers' college" in New York city is an interesting building and might serve equally well the purposes of a modern manual training high school. In universities, the work is specialized in separate buildings which simplifies the task of the architect. The principles of sanitation and architectural treatment indicated in the buildings already referred to apply so

well to special buildings that separate consideration is not considered essential to this short monograph.

INFLUENCE OF LEGISLATION ON SCHOOL ARCHITECTURE

The state of New York in 1887 passed a law authorizing and directing the state superintendent of public instruction to procure architects' plans and specifications for school buildings ranging in cost from $600 to $10000. This was a very important step and it resulted as was intended in enlisting the best architectural talent in the country. Liberal prizes for the most meritorious designs were offered, and as a result some very creditable designs were secured. The suggestions which these designs furnished have been acted upon in many districts not only in New York but in several other states. Following is the list of the names and residences of the architects who presented creditable designs:

Wm. P. Appleyard and E. A. Bowd, Lansing, Mich.
John R. Church, Rochester, N. Y.
John Cox, Jr., New York city.
Clarence True, Yonkers, N. Y.
C. Powell Karr, Rochester, N. Y.
J. C. A. Heriot and Corliss McKinney, Albany, N. Y.
J. Frank Lyman, Yonkers, N. Y.
Warren R. Briggs, Bridgeport, Conn.
Fenimore C. Bate, Cleveland, Ohio.
Proudfoot & Bird, Wichita, Kans.

In 1882, the state superintendent of Wisconsin invited the competition of architects in furnishing designs at small cost. Following are the names and addresses of architects who made valuable contributions:

J. Bruess, Milwaukee, Wisc.
W. G. Kirchaffer, Elkhorn, Wisc.
Edbrooke & Burnham, Chicago, Ill.
H. C. Koch & Co., Milwaukee, Wisc.
G. Stanley Mansfield, Freeport, Ill.
F. S. Allen, Joliet, Ill.
F. W. Hollister, Saginaw, Mich.

In 1895, the state legislature passed a law which says

that:— "Hereafter no school house shall be constructed in the city of New York without an open-air playground attached to or used in connection with the same." This law has done much toward improving the hygienic conditions in New York, and its influence has been felt in other cities.

The state laws of Massachusetts provide for the placing of fire escapes in all buildings more than two stories in height; also "that every school house shall be kept in a cleanly state and free from effluvia arising from any drain, privy, or other nuisance, and shall be provided with a sufficient number of proper water and earth closets." It further provides that "every school house shall be ventilated in such a proper manner that the air shall not become so exhausted as to be injurious to the health of the persons present therein."

The state laws of Kentucky provide that each school house shall have a floor space of not less than ten square feet to each pupil in the district; shall be at least ten feet between floor and ceiling; shall have at least four windows; one or more fireplaces with chimneys made of brick or stone." It also provides that each school house shall provide for each child "a seat with back the height of the seat and its back to suit the age of the child — no desk or bench to be made to accommodate more than two children."

The statutes of Vermont (1896) provide that: "The state board of health shall within reasonable time and as often as it thinks necessary issue a circular letter to the local boards of health giving the best information as to lighting, heating, ventilating, and other sanitary arrangements according to regulations by the state board of health."

The laws of Connecticut provide that "every school house shall be ventilated in such manner that the air shall not be injurious to the health of the persons present therein."

In many of the states the only legislation is that doors in school houses shall open outward. This is a precautionary provision against accidents in fires, and seems to be more generally recognized by state legislatures than any other single necessity.

In many other states there has been no legislation whatever.

In view of the large benefits which have already been realized from the little legislation that has been made in a few states, it is to be hoped that this important means of enlightenment will become more general in the United States.

WORK OF SCHOOL SUPERVISORS AND ARCHITECTS

Next to the good which has been accomplished by state legislation comes that which has been done by state superintendents who, realizing the importance of school architecture, hygiene, and sanitation, have from time to time embodied in their reports valuable information as to the needs of the schools and suggestions as to how to supply them.

In Wisconsin, State Superintendent W. C. Whitford in 1882 issued a valuable circular on "Plans and specifications of school houses" for the country districts, villages, and smaller cities of his state. In 1892 Supt. Oliver E. Wells issued a valuable pamphlet containing suggestions and plans for the ventilation and furnishing of school houses.

In Michigan, State Supt. Henry R. Pattengill in his report for 1894 gave some valuable information on "School grounds, school house architecture, and outbuildings." Also Supt. John E. Hammond in his report for 1897 gives valuable information.

The state board of Connecticut issue from time to time valuable school documents, among which No. 13 is a valuable scientific monograph on "School house warming and ventilating" by S. H. Woodbridge. Documents Nos. 12 and 15 contain suggestions on ventilation, and show a large collection of plans for school houses.

For the state of New York, Supt. Chas. R. Skinner has issued several reports of great value, among which is a large bound volume on "Recent school architecture," and contains a large number of plates showing the plans and perspectives of many of the best school houses in the state.

State Supt. Nathan C. Schaefer of the state of Pennsyl-

vania has given in several of his reports many good suggestions, and has been unsparing in his criticisms on existing conditions in country schools, as a means of stimulating effort toward the improvement of school buildings in his state.

In Missouri, Supt. Jno. R. Kirk has done some excellent work in the improvement of country schools and in his reports of 1896 and 1897 he gives a plan for a model country school house which has been adopted by many of the country districts in the states. This plan possesses the sanitary features described in the other one-room building already described.

Of the architects who have not hereinbefore been mentioned and who have done excellent work in school house building may be named: Robert S. Roeschlaub, Denver, Colo.; E. H. Mead, Lansing, Michigan, whose "three-room building" shown in the Michigan state report for 1898 is especially to be commended; Arthur Bohm, Indianapolis, Ind.; Hudson & Wachter, architects, Toledo, Ohio; Howard & Camdwell, Newark, N. J.; E. A. Joselyn, New York city.

BIBLIOGRAPHY OF SCHOOL HOUSE ARCHITECTURE AND SANITATION

Alcott, William A. Essay on the construction of school houses. pp. 66. Hilliard: Boston, 1832.

Barnard, Henry. School architecture, or contributions to the improvement of school houses in the United States. Sixth edition. pp. 464. Norton: New York, 1854.

Bicknell, A. J. School house and architecture. Trubner: London, 1877.

Chadwick, E. Sanitary principles of school construction. London, 1877.

Chase, C. T. Manual on school houses and cottages for the people of the south. pp. 83. Wash. 1868.

Clark, Theodore M. Rural school architecture. pp. 106. Bureau of education. Wash. 1880.

Construction and maintenance of school infirmaries. Churchill: London, 1888.

Designs for school houses accepted by the department of public instruction of the state of New York. pp. 20, with 19 competitive plans. Albany, 1895.

Designs for school houses accepted by the department of public instruction of the state of New York. pp. 20, forty pages of plans. Albany, 1889.

Dickson system of school house construction. 2000 feet of air per hour for each pupil without mechanical power. School House Construction Company, 215, 217, 219 South Adams street, Peoria, Ill. pp. 35. Peoria, Ill., 1894.

Dukes, Clement. School construction. Lawrence: Rugby, Eng.

Dunham, C. A. The model school house. pp. 35. Burlington, Iowa, 1894.

Eveleth, Samuel F. School house architecture. Illustrated in 17 designs in various styles. pp. 14, 67 plans. Woodward: N. Y. 1870.

Freese, Jacob R. Report on school house and means of promoting popular education. pp. 13. Wash. 1868.

Gardner, E. C. Town and country school buildings. Kellog: N. Y. 1889, contains designs, plans and descriptions.

Gove, Aaron. Public school house. Education 17 (March, 1897) 407–411.

Hints and suggestions on school architecture and hygiene, with plans and illustrations. By J. George Hodgins. pp. 135. Toronto, 1886.

Hodgins, J. George. The school house, its architecture, external and internal arrangements, with elevations and plans for public and high school buildings. pp. 271. Copp: Toronto, 1876.

Johonnot, James. School houses, with architects' designs by S. E. Hewes. Schermerhorn: N. Y. 1872.

Public school buildings in the District of Columbia. pp. 48, House of representatives miscellaneous documents No. 35, 47th Congress, 1st session. Washington.

Report of the general agent (Massachusetts board of education) on the condition of the school houses and giving plans and descriptions of school houses suitable for country towns and villlages. pp. 64. Boston, 1873.

Saeltzer, Alexander. Treatise on accoustics in connection with ventilation; and an account of the modern and ancient methods of heating and ventilation. New York, 1872, 12.

School houses and public buildings. How they may be safely constructed and properly heated and ventilated. Drawings on exhibition at World's Columbian exhibition, pp. 4, 1893 — pp. 33 with plates. (Commonwealth of Massachusetts.)

Turnbull, G. B. New high school building at Colorado Springs. School report, 1 (Dec. 1894): 682.

Walker, C. H. Suggestions on the architecture of school houses, Atlantic, 74 (Dec. 1894): 825.

Plans for heating and ventilating school houses. In state of Maine board of health report, 1891. 315–386.

School architecture and equipment (buildings and grounds)

Robins, E. C. Technical schools and college buildings. pp. 244. Whittaker: London, 1887.

Robins, E. R. School architecture: planning, designing, building. pp. 440. Murray: London, 1877.

Wade, Rufus R. School houses and public buildings: How they may be safely constructed and properly heated and ventilated. pp. 35 — 34 plates of plans, designs, etc. Boston, 1893.

Wheelwright, Edmund M. Series of 17 articles in the "Brickbuilder," Boston, on "The American school house."

Ventilation and sanitation

Briggs, Robert C. Steam heating and exposition of the American practice of warming buildings by steam. Pp. 122. Van Nostrand: New York, 1888.

Bryant, Walter, and Herman, Leopold. An exposition on heating and ventilating the school houses of Boston in 1846 and 1847. pp. 24. Bryant: Boston, 1848.

Colyer, Frederick. Public institutions: their engineering, sanitary and other appliances. pp. 219. Spon: London, 1889.

Griscom, John H. The uses and abuses of air. pp. 252. N. Y., 1850.

Jacob, E. H. Notes on ventilation and warming of houses, churches, schools and other buildings. pp. 124. Young: N. Y., 1882.

Leeds, Lewis W. A treatise on ventilation. pp. 226. N. Y., 1882.

Lupton, N. T. On heating and ventilation, with special reference to the school buildings of Nashville. (Nashville, 1878.)

Marble, Albert P. Sanitary conditions for school houses. pp. 168. Bureau of education: Washington, 1891.

Moore, Joseph A. Ventilation of school buildings in Massachusetts. pp. 15. Chicago, 1893.

Morrison, G. B. Ventilation and warming of school buildings. pp. 22–173. Appleton: N. Y., 1887.

Morrison, G. B. Some thermal determinations in the heating of buildings. Proceedings of "American Association for the Advancement of Science." At Columbus, 1899.

Nichols, W. R. Sanitary conditions of school houses. (Boston, 1880.)

Quimby, H. M., and others. Ventilation of school houses in Worcester. pp. 24. Worcester, 1889.

Ross, G. On the ventilation of schools, hospitals, law courts and other public buildings. Collingrade: London, 1874.

Young, A. G. School hygiene and school houses. pp. 399. Augusta, 1892.

This is the seventh annual report of the state board of Maine, and is the ablest discussion of school hygiene that has yet appeared from a board of health.

Billings, J. S. The information necessary to determine the merits of the heating and ventilation of a school building. Proceedings National educational association, 1882. pp. 11–19.

Hubbard, T. Principles of warming and ventilation as applied to our public schools. (In. pro. san. con. O., 1887. p. 54.)

Walker, William A. Report to N. Y. county board of education on the proper size, construction and means of ventilating school houses, and the arrangement of playgrounds. Docs. of N. Y. city board of education. 1842–1850, pp. 5–12. (1846.)

Woodbridge, S. H. Connecticut school document, No. 13, on "School house warming and ventilation."